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NUCLEAR SCIENCE ABSTRACTS

CHEMISTRY

Analytical Chemistry

Refer also to abstracts 45600 and 47191.

45174 FLUORESCENT X-RAY ANALYSIS OF MICROGRAM QUANTITIES OF URANIUM IN ZIRCALOY. Kawaguchi, Hiroshi; Ouchi, Yoshihiko (Japan Atomic Energy Research Inst., Tokai). Bunseki Kagaku, 18: 1024-7(Aug. 1969). (In Japanese).

The sample is dissolved in HCl and HF. Uranium is separated from Zr by adsorption on an anion-exchange resin from a 6N HCl and is eluted with dilute HCl. Yttrium is added to the effluent as an internal standard, a filter paper that fits the sample holder of the spectrograph is placed in the solution and the mixture is evaporated to dryness. The paper is examined by x-ray fluorescence spectrography. The lower limit of detection is 1.4 μg of U (0.7 ppM in zircaloy) and 2 μg may be determined with relative standard deviation of 20%. (NSA of Japan)

Chemical Procedures

Refer also to abstracts 45262, 45422, 45983, and 46942.

45175 (AI-AEC-12835) SODIUM ANALYSIS WITH SPARK SOURCE MASS SPECTROMETER. Farrar IV, H.; Knox, C. H.; Shepard, R. C. (Atomics International, Canoga Park, Calif.). June 30, 1969. Contract AT(04-3)-701. 45p. Dep. CFSTI.

A spark source mass spectrometer was applied to the determination of impurities in sodium metal. Modifications to the source housing made it possible to introduce the sodium under vacuum, and to cool the sodium during the analyses with liquid nitrogen. Results show that all elements within a broad mass range are simultaneously detected down to 0.1 ppM levels, with none escaping notice. Comparison of the relative concentrations of impurities between sodium samples can be performed with uncertainties generally of less than 30%, but when more precise absolute concentrations are required, it becomes necessary to analyze specially-prepared standards whose impurity concentrations are known. The isotope dilution technique was used with the spark source mass spectrometer to make repeated determinations of iron in sodium. After adding a known quantity of separated iron isotope, the mixed isotopes were preconcentrated and electrodeposited onto gold wire, the surface of which was subsequently sparked. Repeated preliminary measurements gave an iron concentration of 1.68 ± 0.39 ppM. Refinements of the technique can be expected to result in the simultaneous determination of many elements such as Ti, Cr, Fe, Ni, Zr, and Pb with uncertainties of 5 to 10%, and detection limits of less than 0.1 ppM. (auth)

45176 (ANL-7520(Pt.1), pp 25-32) IDENTIFICATION OF SODIUM-IMPURITY SPECIES BY ANALYSIS OF COLD-TRAP CONTENTS. Rodgers, Sheridan J. (MSA Research Corp., Evans City, Pa.).

Two cold traps were removed from MSA Research Corp. operational loops and the contents were analyzed for O_2, C, N_2, H_2, carbon compounds, particle size, and metallic impurities. Cold Trap I-C had operated for 1400 hr and Cold Trap II-O_2 for 2300 hr. Loop I-C had operated with a high-carbon environment such that part of the mainstream flow passed through a bed of graphite rods at 1200°F. Loop II-O_2 had operated with a high-oxygen environment with the cold trap being operated at 700°F to provide oxygen concentration of ~300 ppm O_2. The oxide was concentrated in the region below the mesh and in the first few inches of the mesh. Cold Trap I-C, which operated at 250°F, effectively removed hydrogen, whereas Cold Trap II-O_2 which operated at 700°F did not remove hydrogen. Carbon was found in both cold traps. Cold Trap I-C contained 0.05 lb carbon and Cold Trap II-O_2 0.01 lb carbon. It appeared that mesh must be used in a cold trap if carbon is to be removed effectively. Carbon dioxide, C_2H_2, and HCN were found in both traps at significant levels. Traces of methane, ethane, ethylene, carbonyl sulfide, hydrogen sulfide, cyanogen, and oxymonocyanogen were also found. Iron ranging to 1% was found in Cold Trap I-C; maximum iron concentration in Cold Trap II-O_2 was ~0.5%. On the basis of the relative quantities of CO_2, C_2H_2, and HCN detected during analysis, it is assumed that Na_2C_2 or some acetylene-producing compound, such as a carbonyl, is responsible for carburization of austenitic steels. (auth)

45177 (ANL-7520(Pt.1), pp 278-83) ANALYTICAL METHODS FOR DETERMINING IMPURITIES IN SODIUM BELOW 10 ppm. Bingham, Carleton D.; Scarborough, James M.; Maseda, Mary S. (Atomics International, Canoga Park, Calif.).

In support of a program to measure the solubility in sodium of the elements potentially used in LMFBR cladding or structural material, it has been necessary to modify or develop methods to extend the sensitivity or improve the precision for measurement of the concentration of trace elements in high-purity sodium. The methods for measuring trace quantities of iron, cobalt, nickel, chromium, manganese, copper, bismuth, niobium, and molybdenum are described, and the results of statistical analysis of the data are presented. The effects of the interfering elements investigated are discussed. Items of negative results are also given to provide others with information to prevent their wasted efforts. Potential new or improved methods for future research to further support basic solubility measurements are discussed. (auth)

45178 (ANL-7520(Pt.1), pp 284-90) DIRECT METHOD FOR THE DETERMINATION OF CARBON IN SODIUM. Berkey, Edgar; Hickam, William M. (Westinghouse Research Labs., Pittsburgh, Pa.).

A new approach to the analysis of sodium for total carbon is discussed. The method employs spark-source mass spectrography and requires no chemical treatment of the sample. Past work had established its feasibility for sodium analyses. Now it has been found that detection limits in the low parts per million range for carbon can be readily attained. The carbon blank of the instrument is limited by a combination of procedures that includes periodic baking, exposure only to argon during venting, cryo-pumping the source chamber, and a thorough pre-spark of the samples. The sodium is handled either under vacuum (~10^{-7} Torr) or in high-purity argon and is sparked directly while being cooled with liquid nitrogen. The analysis of 24 samples from a single batch indicates that the precision of the technique is of the order of 10 to 20% and that information on the heterogeneity of carbon in sodium can be obtained. (auth)

45179 (ANL-7520(Pt.1), pp 291-4) TRACE-ELEMENT BEHAVIOR IN SODIUM. Meyer, R. J.; Johnson, C. E.; Ross, L. E. (Argonne National Lab., Ill.).

The problem of segregation of trace constituents within Na samples and the effects that this segregation can have on the reliability of analytical results is discussed. It is pointed out that even if the liquid sample taken from the system is representative, there may also be a problem in sampling the solidified Na. Three separate types of segregation that can occur during cooling and solidification are discussed: precipitation, concentration at a surface, and wall

absorption. Specific examples of ANL experience with these types of segregation are given along with explanations, or possible explanations, for the behavior. Methods of predicting, detecting, and circumventing sample inhomogeneity are also given wherever possible. (P.C.H.)

45180 (ANL-7520(Pt.1), pp 465-70) DETERMINATION OF OXYGEN CONCENTRATION AND MASS-TRANSFER COEFFICIENTS IN SODIUM USING URANIUM. Isaacs, H. S. (Brookhaven National Lab., Upton, N. Y.).

Studies were made on the use of U as a getter for the determination of O_2 concentration and mass-transfer coefficients in Na. The results showed that the rate at which U getters O_2 from Na is proportional to the concentration of O_2 in Na. Possible uses for this method in large, intermediate, and small systems are discussed. (P.C.H.)

45181 (IS-T-309) APPLICATIONS OF THE INDUCTION COUPLED PLASMA TO ANALYTICAL SPECTROSCOPY. Dickinson, George Wilson (Ames Lab., Iowa). Aug. 1969. Contract W-7405-eng-92. 118p. Dep. CFSTI.

Thesis.

The principles of induction heating and their relation to the formation of induction-coupled plasmas are briefly examined. Investigations on the spectroscopic properties and analytical applications of these plasmas revealed that striking improvements in powers of detection of trace elements in solution may be realized through effective optimization of a number of experimental factors. The latter include: desolvation of the nebulized solution before introduction of the sample into the plasma; development of a plasma shape that allows more efficient introduction of the aerosol residue into the plasma; and addition of a remote tuning facility for optimal coupling of the generator to the plasma. Emission detection limits of all elements investigated (including Ce, Hf, Ta, Th, U, W, Zn, and Zr) fall in the fractional microgram to nanogram per milliliter range. For many metals, the observed detection limits range from two to four orders of magnitude superior to the best values so far reported by flame emission and atomic absorption techniques. Calibration curves for Ce, Nb, Ti, and V in Fe are presented. The feasibility of directly and continuously determining the composition of molten metal was experimentally demonstrated. Ultrasonic energy is employed to form finely divided droplets directly from the molten metal. On solidification these droplets form a metallic dust, which is transferred continuously into the high temperature environment of an induction-coupled plasma. The plasma vaporizes the dust and excites the atomic spectra of the constituents in the metal sample. The emitted optical spectra are observed with a recording spectrometer and calibration curves for As and Cu in Sn–Pb solder are presented. These experiments have so far been limited to low-melting alloys of bismuth, lead, and tin. Samples of powdered materials were introduced into the induction-coupled plasma. Devices employed to supply a flow of powder to the plasma are shown and observations made are discussed. (auth)

45182 (ORNL-4396, pp 129-209) CHEMISTRY. (Oak Ridge National Lab., Tenn.).

Topics covered include: chemistry of the MSRE, fission product behavior, physical chemistry of molten salts, chemistry of molten-salt reactor fuel reprocessing technology, and development and evaluation of analytical methods for molten-salt reactors. (D.H.M.)

45183 SAMPLE INPUT SYSTEM. Bayly, J. G.; Rhodes, C. (to Atomic Energy of Canada Ltd.). Canadian Patent 809,902. Apr. 8, 1969.

A delivery system for samples of water under analysis for D_2O isotopic purity is described. An improved method for the control of temperature and pressure in comparison to a set of reference standards is outlined. (F.S.A.)

45184 SPECTROCHEMICAL ESTIMATION OF MOLYBDENUM AND TUNGSTEN IN NIOBIUM OXIDE. Spitz, J.; Chazee, J. J.; Tran Van Danh. Method. Phys. Anal., 4: 375-8(Dec. 1968). (In French).

A dc arc between a graphite counter-electrode and a mixture of a powdered oxide with AgCl is established in a chamber containing 80 % Ar and 20% O for 2 min at 5 A. Then for a further 2 min at 20 A an exposure is made in a large grating spectrograph; from these spectra 2 to 150 ppM of Mo or W can be estimated, giving results which agree well with those obtainable by activation analysis. (Metals Abstr.)

45185 STUDIES OF CHEMICAL AND RADIOCHEMICAL COMPOSITION OF NATURAL GAS FROM THE CAVITY PRODUCED BY THE PROJECT GASBUGGY NUCLEAR SHOT. Smith, Charles F.; Momyer, Floyd (Univ. of California, Livermore). Radiol. Health Data Rep., 10: 281-8(July 1969).

Data relating to the chemical and radiochemical results from Project Gasbuggy chimney-gas samples obtained prior to 210 days after detonation (December 10, 1967) are presented for significant nonradioactive components of the gas and for tritium and krypton-85. A discussion of changes in composition occurring during the flaring of 5×10^7 ft^3 gas in the late spring of 1968 is included. Some interpretation of the observed changes is advanced but with the data now available, no definitive conclusions seem warranted. Major constituents of the Gasbuggy gas during the period from 34 days to 200 days following the detonation were methane (increasing from 37 to 44 percent), ethane (increasing from 4 to 5 percent), propane (constant at ~1 percent), carbon dioxide (constant at ~36 percent), hydrogen (decreasing from 17 to 12 percent) and carbon monoxide (decreasing from 4 to less than 2 percent). Much more significant changes were observed during the first month. The major reactions used to explain these trends are: $CO + H_2O \rightarrow CO_2 + H_2$ and $4H_2 + CO_2 \rightarrow CH_4 + 2H_2O$. Krypton-85 concentration (2.8 μCi/ft^3) NTP (normal temperature and pressure) remained essentially constant over the entire sampling period implying mixing with a constant volume (1.2×10^8 ft^3 NTP) of noncondensable gas during this time. Tritium was observed primarily as hydrogen gas soon after detonations. A rapid decrease in HT came within the first month converting most of the HT to HTO but producing some CH_3T and C_2H_5T. The predominant tritium-containing species, except at very early time, is CH_3T, at a concentration of 12 to 14 μCi/ft^3 NTP. Both CH_3T and C_2H_5T concentrations increased slightly over the first 200 days, that of HT continued to decrease. The ratios CH_3T ·/CH_4 and C_2H_5T/C_2H_6 were essentially constant over the period from 30 to 200 days implying that the exchange equilibrium was attained rapidly. The ratio HT/H_2 continued to decrease over the same period implying a continuing influx of nontritiated water into the chimney and a reasonably rapid exchange reaction between HT and H_2O. Changes in concentrations of cavity gas components as a function of flow rate indicate that removal of 30 percent of the original chimney gas was accomplished by flaring 5×10^7 ft^3 at a rate of 5×10^6 ft^3/day. This result is encouraging but the test was too short to provide verification of this process as a reasonable method of reducing contamination levels. (auth)

45186 THE X-RAY SPECTROMETRIC DETERMINATION OF URANIUM AND PLUTONIUM IN SOLUTIONS OF SPENT NUCLEAR FUELS. Pella, P. A.; von Baeckmann, A. (Kernforschungszentrum, Karlsruhe, Ger.). Anal. Chim. Acta, 47: 431-8(Oct. 1969).

X-ray spectrometry is applied to the determination of uranium and plutonium in dissolver solutions containing fission product activities up to 1330 mCi. Uranium was measured in the concentration range 0.05 to 18 mg/g of solution and plutonium in the range 0.6 to 1.2 mg/g of solution with thorium as an internal standard. Plutonium was determined in the presence of a large excess of uranium and solutions with U/Pu ratios up to 300 were measured. The relative standard deviation of a single measurement was 1.0 to 3.0% over the concentration ranges investigated. The effect of direct γ-radiation from the sample on the detector background was demonstrated and minimized by means of lead shielding. It is suggested that samples with radioactivity levels up to 2 Ci could be measured safely and without seriously increasing the detector background. The application of this method at certain points in the nuclear fuel cycle may be important in the safeguarding of nuclear fuel. (auth)

45187 DETERMINATION OF VALENCE STATES OF IRON IN GLASS AND OF URANIUM IN CALCIUM FLUORIDE SINGLE CRYSTALS. Abed, U. (Univ. of California, Berkeley). Anal. Chim. Acta, 47: 495-502(Oct. 1969).

The instantaneous oxidation of macro and semi-micro amounts of iron(II) in various types of glasses, of iron(II) in magnesium oxide, and of semi-micro quantities of uranium(III) or uranium(IV) in calcium fluoride single crystals by excess of cerium(IV) present in the solvent system, followed by back-titration with iron(II) ammonium sulfate, is the basis for a simple, accurate method that obviates the need for an inert atmosphere. Formal oxidation potentials of the Ce(IV)/Ce(III) couple and the Fe(III)/Fe(II) couple in the hydrofluoric–sulfuric acid glass-dissolving mixture were estimated. (auth)

45188 CHEMICAL IMPRECISION IN THE SPECTROPHOTOMETRIC DETERMINATION OF RUTHENIUM WITH DITHIOOXAMIDE. Lingane, Peter James (Univ. of Minnesota, Minneapolis). Anal. Chim. Acta, 47: 529-37(Oct. 1969).

The precision of a single spectrophotometric determination of ruthenium as the dithiooxamide complex is shown to be about 0.5% and to be limited by chemical rather than instrumental irreproducibility. The molar absorptivity of this complex is $(1.11 \pm 0.02) \times 10^4$ l/mole-cm at 654 nm, considerably smaller than reported previously. It is shown that solutions of ruthenium for use

as spectrophotometric standards may be prepared with a precision of about 0.3% by dissolving weighed portions of the pure metal powder in alkaline sodium hypochlorite at pH ca. 10, taking precautions to avoid the loss of RuO_4 during the dissolution. (auth)

45189 SPECIFIC DETERMINATION OF AMERICIUM WITH A RECORDING SPECTROPHOTOMETER. Buijs, K.; Chavane de Dalmassy, B.; Maurice, M. J. (EURATOM, Karlsruhe, Ger.). Anal. Chim. Acta, 47: 547-50(Oct. 1969).

The development of a procedure for the spectrophotometric determination of americium is presented based on an absorbance measurement of 504 nm. The effects of various anions and cations on the determination of Am in HCl were investigated. The scope of the method is defined as 0.007 to 3 mg of Am/50 ml. The standard deviation for the lower concentration range (<0.2 mg/50 ml) was 0.0022 mg/50 ml and at higher concentration range (>0.2 mg/50 ml) was 0.012 mg/50 ml. (D.H.M.)

45190 QUALITATIVE MICROCHEMICAL ANALYSIS OF MINERALS. Agrinier, H. (CEN, Fontenay-aux-Roses, France). Bull. Inform. Sci. Tech. (Paris), No. 137, 53-76(May 1969). (In French).

The qualitative microanalytical techniques, micro-crystalloscopy and spot tests, are reviewed. Many reactions are described whereby the constituent elements of most minerals can be distinguished rapidly. The weight of the sample being generally of the order of a milligram or less, it is possible to operate on single microcrystals and on very small areas of polished sections. Examples are also given of analyses of varied inorganic species: sulfides, sulfosalts, oxides, and supergenous uraniferous minerals. Because of its rapidity and the simplicity of the materials required, qualitative microanalysis can be practiced in the field as well as in the laboratory. (auth)

45191 QUANTITATIVE ANALYSIS OF Rb AND Sr IN ROCKS BY X-RAY FLUORESCENCE SPECTROMETRY. Hattori, Hitoshi; Shibata, Ken (Geological Survey of Japan, Kawasaki). Chishitsu Chosasho Geppo, 20: 51-76(Jan. 1969). (In Japanese).

For the determination of Rb and Sr, 2.0 g of finely ground rock sample (30 minutes milling in WC grinding vessels of Fritsch's ball mill) was mixed with 2.0 g Panorak, raw material for plastics, as the binder. The mixture was pressed in ϕ 36 mm Al ring between two hardened steel plates at around 2,000 kg/cm^2 to yield a very durable pellet sample. The samples were analyzed with the Holland's Philips PW 1220 semiautomatic x-ray fluorescence spectrometer equipped with a Cr target x-ray tube. Operating conditions are shown. Successive additions of Rb and/or Sr were made on six different rock samples (three granitic rocks, two basaltic rocks, and a graphite schist), so as to obtain the relation between increase rates of net peak intensities. An interference effect was observed in an apparent decrease in the SrKα peak intensity in the presence of Rb. The rate of decrease in the SrKα line was assessed to be -10 cpsec per 1,000 cpsec RbKα increase. Similarly, the rate in the case of the RbKα line, -5 cpsec per 1,000 cpsec SrKα line was obtained. After correction of the net peak intensities, calibration curves were made. Referring to the data determined using a mass spectrometer, seven gradients (ppM per 1,000 cpsec) of A~G were tentatively assigned to twelve rock types. Rb and Sr contents in unknown samples were determined on the basis of this classification. (NSA of Japan)

45192 IONIZATION ENERGY DIFFERENCE BETWEEN ISOTOPES AND ITS EFFECT ON ISOTOPE ABUNDANCE MEASUREMENT BY SURFACE IONIZATION METHOD. Ueda, Nozomu (Tokyo Univ.). Shitsuryo Bunseki, 17: 643-7(June 1969).

For mass spectrophotometric measurement of isotope abundance, the finite nucleus mass effect and the finite volume effect on ionization energy are considered. Theoretical calculation and spectroscopic data show that the ionization energy difference between ^{7}Li and ^{6}Li is 1×10^{-4} eV, and for Li the isotope effect on ionization energy can amount to the same order of magnitude as those mass discriminations by evaporation of the sample from the filament, by ion optics in the ion source chamber, etc. (NSA of Japan)

45193 DETERMINATION OF 10^{-6} TO 10^{-3} PERCENT OF TELLURIUM IN COPPER OR NICKEL BY ALTERNATING-CURRENT POLAROGRAPHY. Pats, R. G.; Semochkina, T. V. Sb. Nauch. Tr. Gos. Nauch.-Issled. Inst. Tsvet. Metal., No. 27, 50-2(1967). (In Russian).

A 10-g sample of the metal is dissolved in HNO_3 (1:3), and the solution is diluted to 100 to 200 ml. An aliquot of the solution is taken, and 2.5 or 5 ml of 29% $FeCl_3$ solution are added to produce a ratio of Fe to Te of 10:1 or more and a content of Fe of 1.5 to 3 mg. To this solution is added 5 ml of 1:1 HCl, the solution is diluted to ~50 ml, and aqueous NH_3 is added to coprecipitate Te with $Fe(OH)_3$. The precipitate is dissolved in a little 1:1 HCl, reprecipitated, dissolved in HCl, and twice evaporated to fumes with 0.2 ml portions of concentrated H_2SO_4. The residue is diluted to a final volume containing up to 1 mg of Te/l, and 0.4 ml of concentrated HI or 2.4 ml of 2N KI is added for each 10 ml of final solution. The final solution is de-oxygenated and subjected to polarography. The peak due to Te is at -0.5v. The sensitivity of the determination is 2×10^{-5}% of Te in a 2-g sample in a final volume of 10 ml. The following elements do not interfere with tolerable amounts relative to Te given in parentheses: Fe (6000), Cu, Zn, Sb (1000), Pb, Bi (500), Cd, Sn, Pd, Se, Ag (100), Mo (50), Pt (5), and As (1). From 0.001 to 0.01% of Te may be determined in a basal solution of 1M tartaric acid by dissolving the precipitate of the $Fe(OH)_3$ plus Te in 15 ml of 50% tartaric acid, diluting to 50 ml, and subjecting to polarography. The peak due to Te is at -1.0v. In either determination the error is <18%. The method may be used to determine Te in metals that form soluble complexes with NH_3. (Anal. Abstr.)

45194 POLAROGRAPHIC DETERMINATION OF IODIDE IN WATER. Hetman, J. S.; Puyo, M.; Thiel, R. (Central Recherches, Pau, France). Bull. Cent. Rech. Pau, 2: No. 1, 183-9 (1968). (In French).

Iodide is determined in water by the oxidation of I^- to IO_3^- by an aqueous solution of Cl and the polarographic determination of IO_3^-. A sample of 1 to 2 ml is acidified to a pH of 1.0 to 1.5 with H_2SO_4. Five ml of a freshly prepared warm aqueous Cl solution are added, and the solution is allowed to stand for 5 min. The solution is then boiled to expel all the Cl_2, evaporated to 2 to 2.5 ml, and an equal volume of hexamine electrolyte and 50 μl of 0.2% $FeCl_2 \cdot 6H_2O$ are added. The solution is de-oxygenated by the passage of a mixture of N_2 and H_2 for 4 to 5 min, and the solution is then analyzed by a cathode-ray or pen-recording polarograph at a starting potential difference of -0.70v. With the cathode-ray polarograph, 1 ml of sample is sufficient and the analysis can be completed in 10 to 15 min. The accuracy and reproducibility are within the limits acceptable for conventional analytical methods. (Anal. Abstr.)

45195 FIRST COMPILATION OF ANALYTICAL DATA ON STRONTIUM ISOTOPES FOR THE NEW GEOCHEMICAL ROCK STANDARDS, JB-1 AND JG-1. Kurasawa, Hajime (Geological Survey of Japan, Kawasaki). Shitsuryo Bunseki, 17: 649-52 (June 1969). (In Japanese).

Determinations of minor constituents and isotopic compositions of Sr reported by analysts throughout Japan are presented for the new series of standard samples issued from the Geological Survey of Japan. Two rock standard samples are still available. (NSA of Japan)

45196 ON THE PHOTOMETRIC DETERMINATION OF ZIRCONIUM CONTENT IN STEEL AND ITS STRUCTURAL CONSTITUENTS. Keller, Helmut; Hennesen, Klaus (Max-Planck-Institut fuer Eisenforschung, Duesseldorf). Arch. Eisenhuettenw., 39: 921-4(Dec. 1968). (In German).

Techniques for the photometric determination of Zr in alloyed and unalloyed steels and in isolated structural constituents are described; the color reagent is Xylenol Orange. This reagent forms colored compounds with several other elements, among them Fe; therefore, two separation methods were worked out for Zr analysis in steel. They are equivalent with respect to accuracy of determinations and to time expended. In the cupferron procedure, Zr is precipitated with cupferron after reduction of Fe to Fe(II). Alternately, Zr is precipitated with Al as collector by NH_3, with thioglycollic acid added to keep other elements in solution. The precipitated cupferronate or hydroxide is purified from remaining impurity by a carbonate and a bisulfate decomposition, and Zr determined in H_2SO_4 with Xylenol Orange. The method allows determination of Zr content to 0.0003%; the sensitivity in constituent of structures is 5 μg. (BBB)

45197 DETERMINATION OF SMALL AMOUNTS OF GADOLINIUM IN EUROPIUM OXIDE USING THE LUMINESCENCE OF CRYSTAL PHOSPHORS. Karyakin, A. V.; Anikina, L. I.; Binh, Le Viet (Inst. of Geochemistry and Analytical Chemistry, Moscow). Zh. Anal. Khim., 24: 1156-9(Aug. 1969). (In Russian).

A direct luminescent method is suggested for determining gadolinium in europium oxide using crystal phosphors based on $Y_2O_3 + Eu_2O_3$ (100:1). The sensitivity of the method is 1×10^{-3}%. Another luminescent method was developed for determining small amounts of gadolinium in europium oxide after the enrichment of the sample by a partition chromatographic method on Teflon. The sensitivity of the method is 1×10^{-4}%. The reproducibility of the method at small concentrations of gadolinium is 20 to 30%. (auth)

45198 CONCENTRATION OF SMALL AMOUNTS OF ZIRCONIUM AND HAFNIUM WITH CERTAIN ORGANIC INDIFFERENT COPRECIPITATORS. Moroshkina, T. M.; Savinova, G. G. (Leningrad State Univ.). Zh. Anal. Khim., 24: 1165-7(Aug. 1969). (In Russian).

Optimum conditions for the precipitation of zirconium and hafnium 8-hydroxyquinolinates with phenolphthalein were found (pH 4, 0.3 of the coprecipitator). β-Naphthol, thymolphthalein, and diphenylamine were used as indifferent coprecipitators. They precipitate from 85 to 90% of zirconium and hafnium from solutions. A method is suggested for obtaining the concentrate, and conditions were chosen for the spectrographic determination of zirconium and hafnium. (auth)

45199 DETERMINATION OF RUTHENIUM(III) ON THE BASIS OF ITS CATALYTIC EFFECT ON THE OXIDATION OF O-DIANISIDINE BY PERIODATE. Kalinina, V. E.; Yatsimirskii, K. B.; Zimina, T. S. (Ivanovo Chemico-Tech. Inst., USSR). Zh. Anal. Khim., 24: 1178-82(Aug. 1969). (In Russian).

A method is suggested for determining 10^{-6} to 10^{-5} mg/ml of ruthenium(III) on the basis of its catalytic effect on the oxidation of o-dianisidine by periodate. Optimum conditions were found. The method permits the determination of ruthenium in hydrochloric, sulfuric, and perchloric acid solutions (0.1 and 0.01N), with an error of not more than 10%. The effect of foreign ions on the ruthenium determination was studied. Iridium and palladium ions interfere. (auth)

45200 DETERMINATION OF MICROAMOUNTS OF RUTHENIUM ON THE BASIS OF ITS CATALYTIC EFFECT OF THE OXIDATION OF BENZIDINE BY HYDROGEN PEROXIDE. Morozova, R. P.; Yatsimirskii, K. B. (Ivanovo Chemico-Tech. Inst., USSR). Zh. Anal. Khim., 24: 1183-7(Aug. 1969). (In Russian).

A method was developed for determining ruthenium on the basis of its catalytic effect on the oxidation of benzidine by hydrogen peroxide. The effects of various factors on the results of the ruthenium determination by the kinetic method were studied. (auth)

45201 DETERMINATION OF RUTHENIUM IN SULFURIC ACID SOLUTIONS BY MEANS OF ELECTROLYSIS AT A CONTROLLED POTENTIAL. Avdeev, D. K.; Prelovskii, V. V.; Tekster, E. N. (Leningrad Tech. Inst.). Zh. Anal. Khim., 24: 1188-90(Aug. 1969). (In Russian).

A method was developed for the coulometric determination of ruthenium at a controlled potential. The method permits the determination of the degree of ruthenium oxidation in sulfuric acid solutions. The minimum determinable amount of ruthenium is 0.05 mg. (auth)

45202 DETERMINATION OF RUTHENIUM BY AN ATOMIC ABSORPTION METHOD. Makarov, D. F.; Kukushkin, Yu. N. (Norilsk Mining-Metallurgical Group of Enterprises, USSR. Leningrad Tech. Inst.). Zh. Anal. Khim., 24: 1191-3(Aug. 1969). (In Russian).

Optimum conditions were found for the determination of ruthenium by an atomic absorption method using a propane-air flame. It was established that salts of other precious metals do not affect practically the sensitivity of the ruthenium determination. The salts of iron, nickel, cobalt, magnesium, calcium, barium, and aluminum decrease the sensitivity, whereas cupric, lithium, and sodium salts increase the sensitivity of ruthenium determination to a certain extent. Under optimum conditions the sensitivity of ruthenium determination is 2 μg/ml. (auth)

45203 SPEKTROFOTOMETRICHESKIE METODY OPREDELENIYA INDIVIDUAL'NYKH REDKOZEMEL'NYKH ELEMENTOV. (Spectrophotometric Methods of Determining Individual Rare Earth Elements). Poluektov, N. S.; Kononenko, Kononenko. Kiev, Izdatel'stvo Naukova Dumka, 1968. 172p.

A detailed review is given on spectrophotometric methods for determination of individual rare earths based on absorption, ion luminescence, and flame photometry. Descriptions are given of the instruments and techniques used for determining rare earth elements in oxide mixtures and in various complex solutions. Determinations of Ce, Eu, Tb, Dy, Sm, Y, Be, Zr, Th, and U by spectrofluorometric and flame spectrophotometric methods are described. (428 references) (R.V.J.)

45204 POTENTIOMETRIC TITRATION OF FREE ACID, URANIUM(IV), (VI), AND HYDRAZINE MONONITRATE IN URANOUS NITRATE SOLUTIONS WITH ALKALI. Emura, Satoru; Okazaki, Shuji (Japan Atomic Energy Research Inst., Tokai). Bunseki Kagaku, 18: 976-80(Aug. 1969). (In Japanese).

A simple method for determination of free acid, U(IV), (VI), and hydrazine mononitrate in uranous nitrate solutions by alkalimetry was investigated. In this method, "free acid" is titrated by standard alkali solution after the U(VI) is masked with $(NH_4)_2SO_4$ and the U(IV) is precipitated by NaF. After the equivalence point for the free acid is reached, H_2O_2 is added to the solution and then liberated acid equivalent to U(VI) is titrated with the same alkali solution. Another sample is oxidized by air bubbling through the solution heated to ~50° to 60°C, the U(VI) is then masked with $(NH_4)_2SO_4$ and "free acid after oxidation" is titrated by the same alkali solution. After the equivalence point for the free acid is reached, formaldehyde solution is added and liberated HNO_3 equivalent to hydrazine mononitrate is titrated with the same alkali solution. The difference of "free acid after oxidation" and "free acid" is equivalent to U(IV). The results of the determination for uranous nitrate solutions, as a control analysis in fuel reprocessing pilot plant, show the coefficient of variation about 0.4 ~ 1.3%. (NSA of Japan)

45205 DETERMINATION OF MICRO AMOUNTS OF URANIUM IN PURE THORIUM NITRATE. Desai, S. R.; Sudhalatha, Kum. K. (Bhabha Atomic Research Centre, Trombay, India). Analyst, 94: 699-700(Aug. 1969).

A method is presented for the determination of 1 ppM or less of uranium in thorium nitrate. Uranium is separated from the latter by ethyl acetate extraction and is determined fluorimetrically, after removing the extracted thorium from the organic phase, by scrubbing it with EDTA–aluminum nitrate solution. The relative standard deviation of the method at 1.00 ppM level of uranium is ± 2.7 per cent. (auth) (UK)

45206 SPECTROPHOTOMETRIC DETERMINATION OF URANIUM BY CHROME AZUROL S IN THE PRESENCE OF POLYVINYL ALCOHOL. Skrdlik, Miloslav; Havel, Josef; Sommer, Lumir (Purkyne Univ., Brno). Chem. Listy, 63: 939-45 (Aug. 1969). (In Czech).

A spectrophotometric method for the determination of uranium(VI) using Chrome Azurol S at pH 6.8 to 7.0 and 600 nm in solutions containing poly(vinyl alcohol) is described. Under these conditions, the results are reproducible and the minimum amount that can be determined is 28 ng U/cm² (ΔA = 0.01). The effect of the extinction of the reagent itself at 600 nm and at pH > 7 is considerably decreased and many interfering ions can be masked by a mixture of the Ca-chelate of DCTA and of sulfosalicylic acid. (auth)

45207 PHOTOMETRIC DETERMINATION OF MANGANESE IN THORIUM COMPOUNDS: AN EXAMINATION OF AMMONIUM PERSULFATE METHOD. DETERMINATION OF IMPURITIES IN THORIUM. 5. Ichinose, Norio (Yamaguchi Univ., Japan). Bunseki Kagaku, 18: 1030-2(Aug. 1969). (In Japanese).

Traces of Mn in Th compounds can be determined spectrophotometrically as the violet-colored permanganate ion. A 1 to 2.5 g sample as ThO_2 is dissolved by heating in HNO_3 containing a few drops of HF. The residue is dissolved in 0.5N HNO_3, and the solution is heated gently until it boils. A few drops of $AgNO_3$ (1%) and 0.5 ml of $(NH_4)_2S_2O_3$ (20%) are added to the solution and it is gently heated for ~1 min to oxidize the Mn to MnO_4^-. The solution is transferred into a 25-ml volumetric flask and diluted to volume. The absorbance of the violet color is measured at 545 mμ using 5 cm cells. Amounts of Mn above 2 ppM (Mn/ThO_2) can be determined by this method. (NSA of Japan)

45208 STUDIES ON SPECTROCHEMICAL ANALYSIS OF RARE EARTH ELEMENTS. 2. SPECTROCHEMICAL DETERMINATION OF TRACE AMOUNTS OF RARE EARTH ELEMENTS BY VACUUM CUP ELECTRODE. Osumi, Yasuaki; Kato, Akihiko (Government Industrial Research Inst., Osaka). Bunseki Kagaku, 18: 992-8(Aug. 1969). (In Japanese).

A spectrochemical method employing a vacuum cup electrode for determination of traces of rare earths is described. The limits of detection are 3 to 17 ppM in an ac arc discharge and 3 to 35 ppM in a high-voltage spark discharge with a coefficient of variation of 5 to 17%. The spectral lines of trace elements are intensified remarkably in an ac arc discharge in Ar, while the reproducibility becomes lower. Cesium, Ba and Al have little effect on the spectral line intensities. They increase gradually as the concentration of matrix La or Pr increases. In practical analysis, the optimum amount of matrix elements is 2 to 5%, and the use of these in a definite concentration is important for accurate determination. The proposed method is useful for determination of traces of rare earth elements in solution. (NSA of Japan)

Isotopic Procedures

Refer also to abstracts 45402 and 45834.

45209 A SIMPLIFIED RADIOISOTOPIC PROCEDURE FOR THE DETERMINATION OF CALCIUM AND PHOSPHORUS AVAILABILITY. Whittemore, C. T.; Thompson, A. (Univ. of Newcastle upon Tyne, Eng.). Proc. Nutr. Soc., 28: 16A-17A(Mar. 1969).

A carcass ratio procedure is described that allows availability to be calculated using radionuclide recovery data from a pair of animals, 1 dosed orally, the other intramuscularly with identical amount of ^{45}Ca and ^{32}P. The ratio so obtained measures directly the proportional absorption of radionuclide through the intestinal

wall. The method was tested with rats. The application of the ratio method to larger animals, such as the pig, would raise problems of handling and subsampling of large quantities of material. Therefore, the use of femur and femur diaphysis ratios was also investigated. The results showed that the carcass ratio procedure compares favorably with the comparative balance, and that the whole femur and femur diaphysis are equally useful samples for the estimation of availability. However, the femur diaphysis has a lower rate of deposition of radionuclide than the epiphyses; problems concerned with the separation of the diaphysis from the epiphyses may reduce the accuracy of this method. The ratio procedures appear to offer satisfactory alternative to the comparative balance, choice of the carcass or the whole bone ratio being governed largely by the size of the animal involved. (BBB)

45210 THE USE OF ISOTOPES IN POLYMER ANALYSIS. Ayrey, G. (London Univ.). Fortschr. Hochpolym.-Forsch., 6: 128-48(1969).

The following aspects of the use of isotopes in polymer analysis are reviewed (with 94 references): advantages of isotopic methods and some limitations, the kinetic isotope effect, some experimental aspects, analytical methods, copolymer analysis, unsaturation analysis, crosslink analysis, diffusion, adsorption, degradation, poly(vinyl chloride) stabilization, free radical polymerization, and ionic polymerization. A table gives a list of the following isotopes which may be useful to the polymer chemist, along with their type of decay, half-life, and maximum sp act. or at. % excess: ^{2}H, ^{3}H, ^{13}C, ^{14}C, ^{15}N, ^{18}O, ^{32}P, ^{35}S, ^{36}Cl, ^{55}Fe, ^{82}Br, ^{113}Sn, and ^{125}I. Unique advantages of isotopic methods include: (1) extreme sensitivity, thus dilutions of several millionfold are readily accommodated; (2) ability to label specific atoms in complicated molecules and to trace their fate through any number of operations; (3) analysis with isotopes can often be nondestructive; (4) possibility of tracing dynamic mechanisms, to follow the rate of formation of a particular intermediate compound in a system where there is no net synthesis, or to establish reversibility in a reaction, which apparently goes to completion; and (5) study of reaction mechanisms is possible. Limitations of their use are also discussed. (BBB)

45211 RADIOISOTOPE METHODS OF ANALYSIS AND CHARACTERIZATION OF ELASTOMERS. Campbell, D. R.; Warner, W. C. (General Tire and Rubber Co., Akron, Ohio). Rubber Chem. Technol., 42: 1-29(Feb. 1969).

The following aspects of the use of radioisotopes in rubber technology are reviewed (with 146 references): application of isotopes in studies on vulcanization and the interaction of compounding ingredients (estimation of state of cure, radiochromatography in separation and exchange studies, determination of polysulfide bonds by sulfur exchange, detection of nonexchange interactions, sulfur-accelerator exchange reactions); diffusion and dispersion (role of diffusion and dispersion in elastomer technology, radioisotope diffusion studies and polymer structure, methods of study of sulfur diffusion and dispersion, diffusion and dispersion of components other than sulfur, significance of radiochemical purity of labeled penetrants); adsorption and coagulation (solids adsorption on dipped tire cord and coagulation, ionic deposition, and gelation of latexes); radioreagent methods; and applications of special radioisotope techniques (activation methods of elemental analysis, dating and identification of products, detection of physical transformations of elastomers, application of the Moessbauer effect, use of the clathrate form of inclusion complexes). (BBB)

45212 THE DETERMINATION OF ARSENIC IN ORGANIC AND INORGANIC ARSENIC COMPOUNDS: A RADIOISOTOPE-DILUTION SUBSTOICHEIOMETRIC APPLICATION. Arnold, Alphonso; Davis, Sidney; Jordan, Almetia L. (Dept. of Health, Education, and Welfare, Washington, D. C.). Analyst, 94: 664-9(Aug. 1969).

A substoichiometric isotopic-dilution method was applied to the determination of microgram amounts of arsenic. The arsenic compound is subjected to wet acid digestion, radiolabelled with arsenic-74 standard solution, and complexed and extracted with a limiting amount of zinc diethyldithiocarbamate in chloroform. Results are given for fifty-seven determinations in nine organic compounds and sixty-eight determinations in seven inorganic compounds. Average recovery values of 99.7 ± 2.7% and 98.5 ± 2.6%, respectively, are included. Exclusive of digestion time, twenty replicates of a single sample can be completed in 1 hour. (auth) (UK)

Radiometric Procedures

Refer also to abstracts 45394 and 45608.

45213 (UCRL-Trans-10370) ESTIMATION OF ^{90}Sr IN MILK ASH. Ballada, Jean; Jeanmaire, Lucien (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by B. J. Hazzard for Univ. of California, Lawrence Radiation Lab., Livermore, from report CEA-R-3653). 19p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 15810.

45214 FURTHER STUDIES OF A UNIVERSAL METHOD FOR THE CONTINUOUS RADIOACTIVITY MEASUREMENT OF ^{3}H- AND ^{14}C-LABELED COMPOUNDS AFTER GC. Tykva, R. (Inst. of Organic Chemistry and Biochemistry, Prague); Simon, H. Chromatographia, 2: 5-10(1969).

Using a procedure for the determination of the radioactivity of ^{3}H- and ^{14}C-labeled compounds after gas chromatographic separation using a flow-proportional counter a higher detection sensitivity was attained than with an ionization chamber or scintillation counter. An oxidation method usually gave sharper peaks and a counting yield relatively 10 to 20% higher than cracking in a stream of H_2. The method can also be used for fast radioactivity analysis by direct injection into the reaction tube. This offers the possibility of fast radioactivity determination of vaporizable ^{14}C-labeled compounds. Different reactor fillings were investigated, the influence of parameters such as gas flow rate and gas composition was evaluated, and the possibility of low-level measurements investigated. Substances containing O, N, S, or halogens did not affect the counter performance. An anticoincidence arrangement for measuring very low radioactivities is described. (BBB)

45215 DETERMINATION OF FAT IN MILK, USING THE PULSE-HEIGHT DISTRIBUTION DERIVED FROM LIGHT SPECTRA OBTAINED VIA RADIOACTIVE SOURCES. de Swart, J. G. (ITAL, Wageningen, Netherlands); Kerkhof Mogot, M. E.; Koops, J. Neth. Milk Dairy J., 23: 136-9(1969).

Data are given on the determination of the fat content of milk using a ^{14}C-compound in a liquid scintillator-mixture as a pulsed light source. The emitted light of this source was measured by pulse-height spectral analysis. Preliminary results are given on bulk and individual milks. Further research is needed to gain a better insight into the merits of this method. (auth)

45216 DETERMINATION OF SMALL AMOUNTS OF ^{99}Tc IN FISSION PRODUCTS. Ueno, Kaoru (Japan Atomic Energy Research Inst., Tokai). Nippon Kagaku Zasshi, 90: 718-19 (July 1969). (In Japanese).

A method is presented for the determination of ^{99}Tc ($T_{\frac{1}{2}} = 2.12$ 10^5 yr) in fission products based on an isotope dilution technique with the aid of ^{99m}Tc as a radioactive tracer. Labeled Tc is purified and separated by the extraction of pertechnetate into chloroform in the presence of tetraphenylarsonium ion. Ten to 0.25 mμCi of ^{99}Tc can be determined by this method. (NSA of Japan)

45217 SCANNING OF IRRADIATED NUCLEAR FUEL BY MEANS OF PHOTONEUTRONS PRODUCED IN BERYLLIUM AND HEAVY WATER BY γ-RAYS EMITTED BY FISSION PRODUCTS. Lazzarini, E.; Terrani, M. (Politecnico, Milan). Energ. Nucl. (Milan), 16: 557-65(Sept. 1969). (In Italian).

Deuterium and beryllium irradiated with γ rays of energy higher than 2.226 and 1.666 MeV, respectively, undergo the (γ, n) reaction. From the data reported in literature concerning the fission products one can infer that after few days of cooling photodissociation of deuterium can be promoted only by γ rays emitted in the decay of ^{140}La, daughter of ^{140}Ba, while the (γ, n) reaction in ^{9}Be can be also promoted by γ rays emitted in the decays of ^{132}I, daughter of ^{132}Te, and ^{144}Pr, daughter of ^{144}Ce. Therefore if a deuterium target is irradiated with γ rays coming from irradiated nuclear fuel, the neutron counting is related only to the amount of ^{140}La present in the fuel. As a consequence the neutron counting gives information about the burnup during the last twenty days of irradiation, the half-life ^{140}Ba being 12.6 d. If a beryllium target is irradiated with fission product γ rays, the neutron counting is related to the amounts of ^{132}I, ^{140}La, and ^{144}Pr. After one month of cooling the contribution of ^{132}I is negligible, and after 2 to 3 months the neutron counting due to ^{144}Pr becomes predominant. Thus neutron counting gives information about burnup during the whole irradiation since the half-life of ^{144}Ce is 280 d. The practical aspects of the feasibility of this method for scanning of irradiated nuclear fuel are discussed. (auth)

45218 RADIOMETRIC METHOD FOR THE INTERFERENCE-FREE DETERMINATION OF SMALL BORON CONCENTRATIONS. Moser, E. Oesterr. Akad. Wiss. Math.-Naturwiss. Kl., Sitzungsber., Abt. II, 177: 157-69(1969). (In German).

The interference-free determination of B was carried out through the process $^{10}B(n,\alpha)^{7}Li$ with thermal neutrons. The reaction products were registered with the help of two gas flow-through proportional counters, which can operate in the presence of strong β and γ radiation in the reactor. These two counters are arranged in a fixed geometry, in which the samples are used as

part of the cathode. With this method, B concentrations in steel between 100 and 5 ppM can be determined with an accuracy of ±1%. The measurement time is 3 to 4 minutes for neutron fluxes between 10^8 and 2×10^9 thermal neutrons/cm²sec. (tr-auth)

45219 DETERMINATION OF ULTRAMICROQUANTITIES OF ^{226}Ra IN DIFFERENT SAMPLES. Pomanskii, A. A.; Severnyi, S. A.; Trifonova, E. P. At. Energ. (USSR), 27: 36-9(July 1969). (In Russian).

A highly sensitive method for the determination of small quantities of ^{226}Ra in different samples was developed. ^{222}Rn is extracted from the solutions of these samples in liquids, then purified and detected in a low-background proportional counter. By this system as little as 10^{-17} gram ^{226}Ra per gram of sample can be detected. The contents of ^{226}Ra in some samples were measured. (auth)

Activation Procedures

Refer also to abstracts 45262, 45373, 45384, 45574, 45609, 45611, 45998, 46241, 46940, and 47235.

45220 (ANL-7535, pp 246-9) TIME AND ENERGY FACTORS IN THE ACTIVATION ANALYSIS OF BIOMEDICAL SAMPLES. Frigeric, Norman A. (Argonne National Lab., Ill.).

By control of neutron energy, of irradiation and cooling schedules, and of counting methods it was possible to suppress interfering nuclides by factors of 25 or more relative to conventional, thermal neutron, activation analysis. This permitted purely instrumental analysis of 50 to 100 biomedical samples per day for Na, Cl, K, and As/Br in each sample. The methods are generally applicable, and show promise for the purely instrumental analysis of many other nuclides in biomedical samples. (auth)

45221 (CNM-R-2(Vol.1), pp 346-56) NEUTRON ACTIVATION ANALYSIS OF BIOLOGICAL MATERIALS. Campero, A. (Comision Nacional de Energia Nuclear, Mexico City. Centro Nuclear de Mexico); Graber, F. M.; Lukens, H. R. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

Two recent studies on the neutron activation analysis of biological materials, carried out at the General Atomic laboratories in San Diego with the 250-kw TRIGA Mark I reactor, are reported: the purely instrumental determination of fluorine and the simultaneous radiochemical determination of manganese, copper, and zinc. Thermal-neutron fluxes in the range of 2 to 4×10^{12} n/cm²-sec were employed. (auth)

45222 (FEI-128) PHYSICAL BASES OF ACTIVATION ANALYSIS OF CHARGED PARTICLES). Krasnov, N. N. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR [Obninsk]. Fiziko-Energeticheskii Institut). 1968. 17p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The principal correlations necessary for the practical uses of activation analysis by charged particles are considered. The correlations permit determination of elements by both absolute and relative methods. The formulas obtained are based on the use of the concept of isotope yield and an approximate expression for the path-energy ratio. (tr-auth) (CFSTI)

45223 (NYO-3953-1) APPLICATION OF NUCLEAR TECHNOLOGY TO ART IDENTIFICATION PROBLEMS. First Annual Report. Keisch, Bernard (Mellon Inst., Pittsburgh, Pa. Radiation Research Labs.). Feb. 1969. Contract AT(30-1)-3953. 48p. Dep. CFSTI.

Problems are outlined in the preparation of samples of pigment for analysis by neutron activation (NAA). Better definitions of such problems were sought. The methods used for NAA of white lead are described. Preliminary results for NAA of modern samples of white lead are given. Plans for NAA of other samples of white lead, ultramarine, and other pigments are described. Results of the measurement of post-World War II levels of carbon-14 in linseed oil are given and plans are described to use such information in identifying oil paintings produced since the 1950's. Modification of existing procedures to analyze brass and bronze for natural, alpha-emitting, radionuclides is described. (auth)

45224 NEUTRON ACTIVATION ANALYSIS OF HIGH-PURITY SELENIUM. PART V. SIMULTANEOUS DETERMINATION OF METALLIC IMPURITIES. Ballaux, C.; Dams, R.; Hoste, J. (Ghent Univ.). Anal. Chim. Acta, 47: 397-405(Oct. 1969).

Neutron activation analyses for Na, K, Cr, Fe, Co, Cu, Zn, Ga, Ag, Cd, La, W, Au, and Tl in high-purity selenium in the ppM and ppB ranges were performed by irradiating 100-mg samples together with standards at a flux of 10^{13} n cm^{-2} sec^{-1}. The matrix activities from selenium, arsenic, germanium and bromine isotopes were separated by distillation in sulphuric acid-hydrobromic acid at 200 to 220°C. The γ-emitting isotopes were measured simultaneously by γ-spectrometry with a Ge(Li) detector. The pure β-emitter ^{204}Tl was precipitated as tetrathiourea thallium(I) perchlorate and thallium(I) chromate and counted with a G.M.-tube. (auth)

45225 NON-DESTRUCTIVE ANALYSIS OF NUCLEAR FUELS BY RADIATIVE NEUTRON CAPTURE. Michaelis, W. (Institut fuer Angewandte Kernphysik, Karlsruhe, Ger.). Atomkernenergie, 14: 347-51(Sept.-Oct. 1969).

The use of the radiative neutron capture process for the detection, identification, and quantitative analysis of fissile materials was studied. An apparatus that eliminates interfering effects from nuclear fission is proposed. It is shown that the recording of characteristic primary transitions from neutron capture should fulfill all requirements, provided that neutrons of appropriate energy are used. (auth)

45226 FUNDAMENTAL STUDY OF DETERMINATION OF ALKALINE PHOSPHATASE ACTIVITY BY ACTIVATION ANALYSIS. Akaboshi, Mitsuhiko; Kawai, Kenichi (Kyoto Univ. Osaka Research Reactor Inst.). Dobutsugaku Zasshi, 77: 379-82(Dec. 1969). (In Japanese).

Alkaline phosphatase activity was determined by means of the induced radioactivity of ^{32}P derived from the (n, γ) reaction of ^{31}P after enzymic reaction followed by paper chromatography. Disodium p-nitrophenyl phosphate was used as a substrate. Using this method, alkaline phosphatase activity could be measured with a very high sensitivity, viz., more than 200 fold, as compared to ordinary methods. (NSA of Japan)

45227 ON THE STANDARD MATERIAL FOR RADIOACTIVATION ANALYSIS OF CHLORINE. Iwata, Shiro (Kyoto Univ.); Hayashi, Masahiro. Bunseki Kiki, 7: 222-5(Apr. 1969). (In Japanese).

The behavior and the stability of various chlorine compounds generally used as standard samples for radioactivation analysis of chlorine were investigated. As standard materials, such inorganic compounds as NH_4Cl and KCl, such organic chlorine compounds as p-chloroacetanilide and γ-benzene hexachloride, and such high polymer chlorine compounds as polyvinyl chloride, polyvinyl chloride–vinyl acetate copolymer, and polyethylene chloride (PEC) were used. After these samples were irradiated with 5×10^{12} n/cm² sec thermal neutron flux for 20 min in KUR, the specific activity was determined. When inorganic chlorine compound crystal was used, a remarkable self-shielding effect of chlorine was observed, but in the case of solid polyethylene, that effect was not observed at all. Therefore, in using inorganic compounds as the standard sample, it is desirable to make the size of the sample as small as possible so as to minimize the self-shielding effect. If organic chlorine compounds are used, the compounds with high mp and bp are desirable. Polyethylene chloride is recommended as the most suitable standard material for it is more resistant to radiation. (NSA of Japan)

45228 THE DETERMINATION OF LANTHANUM, SAMARIUM, EUROPIUM, AND THORIUM IMPURITIES IN NUCLEAR-GRADE URANIUM PRODUCTS. Turkstra, J.; Behrens, G. B.; de Wet, W. J. (National Nuclear Research Centre, Pelindaba, S. Afr.). J. S. Afr. Chem. Inst., 22: 111-20(May 1969).

Sub-microgram quantities of certain rare earths and microgram quantities of thorium present as impurities in nuclear-grade uranium products were determined by reactor-activation analysis, utilizing high resolution γ-spectrometry. The procedures used involve only a minimum number of chemical separations. The non-destructive determination of at least nine of the individual rare earths by the above method is discussed. (auth)

45229 DETERMINATION OF TRACE ELEMENTS IN SEA-WATER BY NEUTRON ACTIVATION ANALYSIS. Piper, David Z. (Scripps Institution of Oceanography, La Jolla, Calif.); Goles, Gordon G. Anal. Chim. Acta, 47: 560-3(Oct. 1969).

A method of neutron activation analysis is presented by which the abundance of several trace elements can be determined directly and simultaneously in dried sea salt. The elements determined are Co, Cr, Fe, Sr, Rb, Cs, Sc, Sb, and Zn. (D.H.M.)

45230 DETERMINATION OF FREE THYROXINE IN HUMAN SERUM BY NEUTRON ACTIVATION ANALYSIS. Hamada, S.; Torizuka, K.; Hamamoto, K.; Mori, T.; Morita, R.; Nakagawa, T.; Konishi, J. (Kyoto Univ. School of Medicine). Radioisotopes (Tokyo), 18: 354-8(Sept. 1969).

Neutron activation analysis was employed in an effort to directly determine free thyroxine (free T_4) in sera of normal subjects and patients with various thyroid disorders. Nine ml of serum was dialyzed in 114 ml of phosphate-buffered saline at 37°C for 22 hours, and 100 ml of the dialyzate was poured onto anion exchange resins in three successive columns to separate free T_4. Together with iodine standards, the free T_4 obtained was irradiated in the pile at a thermal neutron flux of 4×10^{12}n/cm²·sec for 60 minutes.

The induced ^{128}I was separated by (1) acid digestion and distillation, (2) extraction with carbon tetrachloride, and (3) precipitation with silver nitrate. This process reduced inorganic iodide and iodotyrosine contents to a negligible amount and also eliminated radiochemical impurities. The estimated values of free T_4 for hyperthyroidism were about the same as those obtained by the tracer method, while the values for normal subject and hypothyroidism were considerably higher than by the tracer method. The possible reasons for the high values were discussed. (auth)

45231 PHOTON ACTIVATION ANALYSIS FOR ARSENIC USING SELENIUM AS INTERNAL REFERENCE ELEMENT. Oka, Yoshinaga; Kato, Toyoaki (Tohoku Univ., Sendai). Bunseki Kagaku, 18: 971-5(Aug. 1969). (In Japanese).

Minute amounts of As were determined by photon activation analysis using Se as an internal reference element. When As and Se were irradiated with 20-MeV bremsstrahlung, ^{74}As and ^{76}As were produced respectively by (γ,n) and (γ,p) reactions. A good proportionality was observed between R_{A_0}, the ratio of photopeak area of ^{76}As(0.559 MeV) to that of ^{74}As(0.596 MeV), and R_W, the weight ratio of As to Se: $R_W = (2.00 \pm 0.026) \times 10^{-2}\ R_{A_0}$. About 0.008% of As in Se was accurately determined. (NSA of Japan)

45232 GAMMA ACTIVATION METHOD FOR DETERMINING Se, Y, Ag, Ba, Hf, AND Au. Kodiri, S.; Starchik, L. P. (Tadzhik State Univ., USSR. Moscow Inst. of Natural Fuels). Dokl. Akad. Nauk Tadzh. SSR, 12: No. 5, 17-21(1969). (In Russian).

The γ-activation determination of Se, Y, Ag, Ba, Hf, and Au was accomplished according to the reaction $A(\gamma,\gamma')A^m$ based on the excitation of metastable states of stable isotopes ^{77}Se, ^{89}Y, $^{107+109}Ag$, $^{135+137}Ba$, ^{179}Hf, and ^{197}Au. A linear electron accelerator of 4.2 MeV and 5 μa was used. (R.V.J.)

45233 NEUTRON-ACTIVATION DETERMINATION OF MANGANESE AND COPPER IN CRUDE OIL, ITS FRACTIONS, AND ASHES. Lobanov, E. M.; Umarov, M. U.; Numanov, I. U.; Azizov, N. A. (Inst. of Chemistry, Dushanbe, USSR). Dokl. Akad. Nauk Tadzh. SSR, 12: No. 5, 33-7(1969). (In Russian).

Neutron activation analysis was used for determining (according to their γ lines and half-lives) concentrations of various microelements in small suspensions of oil, its fractions, and ashes. Prepared specimens irradiated by 1.2×10^{3} n/m^2 sec in the thermal column of the WWR-C reactor were measured by γ spectrometers and calibrated according to the γ lines for ^{56}Mn(0.84 to 1.81 MeV), ^{46}Sc(0.89 to 1.12 MeV), ^{51}Cr(0.32 MeV), ^{134}Cs(0.60 to 0.80 MeV), ^{60}Co(1.17 to 1.33 MeV), and ^{64}Cu(0.51 to 1.08 MeV). The method makes possible the determination of from one to four microelements from one photopeak. (R.V.J.)

45234 THE VAPORIZED AMOUNTS, VAPORIZATION BEHAVIOR, AND SPECTRAL LINE INTENSITY OF METALLIC SELENIUM IN GRAPHITE POWDER BY ARC DISCHARGE. Osawa, Hisao (Fuji Electric Co., Yokosuka, Japan). Bunseki Kiki, 7: 619-26(Sept. 1969). (In Japanese).

The relations between vaporized amounts, vaporization behavior, and spectral line intensity of metallic Se in graphite powder were examined with graphite electrodes under varying arc discharge conditions and buffer concentrations. Standard samples were prepared by adding 5% metallic Se and various amounts of LiF as a spectrographic buffer to highly purified graphite powder. The element was excited by a dc arc discharge, and the concentration of metallic Se remaining in graphite powder after the discharge was measured by the neutron activation analysis. It was clarified that the vaporized amounts were increased and the temperature of anode was raised with an increase of the arc current. Under conditions involving an arc current of 5.2 to 5.5A, an electrode gap of 3 mm, a discharge time of 50 sec, and a LiF concentration of 2.0%, the vaporized amounts were 5.0×10^{-6} g/mg sample at the anode crater and 4.8×10^{-6} g/mg sample at the cathode crater in the air, and 4.8×10^{-6} and 1.7×10^{-6} g/mg sample, respectively, in Ar. Metallic Se in the graphite powder was vaporized not only from the surface of the electrode crater but also from its interior. The Ar atmosphere gave, under the same arc discharge conditions as in air, less enhanced vaporization of Se and lower line intensity of Se 2413.5 Å. In air, the ratio of $C_{obs.}$ to $C_{stand.}$ characterizing a vaporization behavior of metallic Se depended mostly on the arc current and discharge time. The sum of vaporized amounts on both anode and cathode craters as well as the line intensity of Se decreased with an increase of the concentration of LiF from 0.5 to 10%. (NSA of Japan)

Inorganic, Organic, and Physical Chemistry

Refer also to abstracts 45180, 45234, 45242, 45273, 45283, 45331, 45356, 45367, 45385, 45395, 46030, 46031, 46279, and 46560.

45235 (ANL-7520(Pt.1), pp 33-8) ALKALINE EARTH IMPURITIES IN SODIUM. Epstein, Leo F. (Argonne National Lab., Ill.).

The effects of Ca and other alkaline earth impurities in Na are discussed. Calcium is universally present in Na because Na is manufactured by the electrolysis of NaCl–$CaCl_2$ mixtures. Normally, the Ca content is of the order of 200 to 500 ppM by weight. For reactor grade Na, this is reduced to 10 ppM or less. Another phenomenon observed with alkaline earths in solution in Na is the reaction at the gas–liquid interface with N_2. The transport of N_2 from the gas phase into the liquid, where it can bring about reaction with immersed materials sensitive to nitriding, is believed to depend markedly on the alkaline earth metal content of the Na. For these reasons, it has been considered desirable to specify low Ca for reactor grade Na, and the use of soluble alkaline earth metals as getters has been questioned. It is also noted that the irradiation of Na results in the production of ^{24}Na, which decays with a 15-hr half-life to stable ^{24}Mg. As a result the problems of alkaline earth metals in Na systems seem unavoidable. (P.C.H.)

45236 (ANL-7520(Pt.1), pp 171-6) EFFECT OF OXYGEN IN SODIUM ON THE COMPATIBILITY OF SODIUM WITH NIOBIUM. Klueh, R. L. (Oak Ridge National Lab., Tenn.).

Previous studies of the compatibility between refractory metals (mainly niobium and tantalum) and the alkali metals sodium and potassium have shown that the dissolution of the refractory metal in the alkali metal depends upon the concentration of oxygen in the alkali metal. It has also been observed that the experimentally determined equilibrium distribution coefficient for oxygen at a given temperature (i.e., the ratio of the oxygen concentration in the refractory metal to that in the alkali metal at equilibrium) is generally much smaller than the theoretically calculated value. These observations have generally been explained by postulating the formation of a ternary oxide containing refractory metal, alkali metal, and oxygen atoms. As an alternative to the ternary-oxide hypothesis, it is proposed that at equilibrium a liquid ternary solution exists and that the oxygen affects the solubility of the refractory metal by decreasing the activity coefficient of the refractory metal in the liquid. The phase rule has been used to check this hypothesis in the niobium–oxygen–sodium system at 600°C. The interaction between niobium and oxygen in sodium has been characterized using the interaction parameters developed by Wagner, and these results were used to show how the discrepancy in distribution coefficient can be resolved. (auth)

45237 (ANL-7520(Pt.1), pp 295-8) SOLUBILITIES OF NITROGEN GAS AND SODIUM CYANIDE IN LIQUID SODIUM. Veleckis, E.; Anderson, K. E.; Cafasso, F. A.; Feder, H. M. (Argonne National Lab., Ill.).

Nitrogen solubility measurements involved saturating approximately 2.5 l of reactor-grade sodium at a preselected temperature with N_2 at 10 atm, stripping the dissolved N_2 from ~2 l of Na with He, trapping the stripped gas on liquid-N_2-cooled molecular sieves, transferring it to a bulb, and, finally, analyzing it with a mass spectrometer. Measurements were made at 50° intervals between 450 and 600°C with the aid of N_2 enriched with ^{15}N. The results appeared to be consistent with the mechanism of diatomic solution of molecular N_2 in Na. The solubility of NaCN in liquid Na was determined by direct sampling. Solubilities were measured both below and above the monotectic temperature, which was found by thermal analysis to be 565 ± 2°C. It is speculated that relatively low solubility of cyanide in Na is due to its lack of spherical symmetry. Data are tabulated. (P.C.H.)

45238 (ANL-7520(Pt.1), pp 299-308) SOLUBILITY OF COBALT AND NICKEL IN SODIUM. Lee, Pang-Kai; Berkey, Edgar (Westinghouse Research Labs., Pittsburgh, Pa.).

The solubilities of cobalt and nickel in liquid sodium were studied separately over the temperature range from about 280 to 500°C. A classical equilibration procedure was employed, exposing a high-purity cobalt or nickel crucible to sodium at the desired temperature. A vacuum chamber (at 10^{-6} to 10^{-7} Torr) was used to protect the purity of the reactants. The solubility data were obtained by analyzing the resultant sodium by spark-source mass spectrography. The spread observed in the results can be attributed to local inhomogeneities in the solid samples analyzed. Both cobalt and nickel appeared to have sodium solubilities in the low parts per million range and below, with experimental heats of solution within a factor of two of their heats of fusion. Possible factors affecting the solubility are discussed. (auth)

45239 (ANL-7520(Pt.1), pp 319-24) THE SOLUBILITY OF Cu, Mo, Nb, Fe, Ni, AND Cr IN HIGH-PURITY SODIUM. Eichelberger, R. L.; McKisson, R. L. (Atomics International, Canoga Park, Calif.).

Data on the solubility of Cu, Fe, Mo, Ni, and Nb in relatively oxygen-free Na are tabulated. Values for $\Delta H_{(soln)}$ were found to be 15.7, 17.4, 4.2, and 16.1 kcal/g-atom, for Cu, Mo, Ni, and Nb, respectively. The Cr results obtained were considered question-

able, because significantly less Cr was found by atomic absorption spectrometric analysis than seemed to be present in the sample collector before the Na was removed. (P.C.H.)

45240 (ANL-7520(Pt.1), pp 477-80) CALCULATED HYDROGEN-OXYGEN EQUILIBRIA IN LIQUID SODIUM. Vilinskas, Peter (Argonne National Lab., Ill.).

The results of the thermodynamic calculation for the H_2-O_2 equilibria in Na are presented, and the effects of these equilibria on measurements of H_2 and O_2 solubility and the output of some in-line instruments are considered. The following equation formed the basis of the calculation: $NaOH(c) + Na(c) \rightleftharpoons Na_2O(c) + \frac{1}{2} H_2(g)$. The effects of hydroxide formation on solubility measurements of sodium oxide and hydrogen gas in Na and the stability of NaOH as a separate phase in the presence of Na are discussed. (P.C.H.)

45241 (BARC-375) STUDIES ON THE USE OF URANIUM(IV) AS A REDUCTANT FOR PLUTONIUM IN PUREX PROCESS. Srinivasan, N.; Laxminarayanan, T. S.; Balasubramanian, G. R.; Kapoor, S. C.; Ramaniah, M. V.; Rao, C. L.; Pisharody, K. P. R.; Jadhav, A. V.; Vishwanatha, A. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 49p. Dep. CFSTI (U. S. Sales Only).

Stainless steel, tantalum, and mercury cathodes were studied in the electrolytic preparation of U(IV) solutions in nitric acid, in the presence of hydrazine as the stabilizer. The current efficiencies of these electrodes are reported. Mercury cathode was found to be the most suitable. The dependence of current efficiency on the current density, nitric acid, and initial U(VI) concentrations was studied. A two compartment glass cell was designed for preparing U(IV) solutions on a large scale. Several two litre batches of 1.0M uranyl nitrate in 2 to 4M nitric acid containing hydrazine were reduced completely to U(IV) using mercury cathode. The overall current efficiency obtained was 85% and the reduction was complete in 25 to 30 hours. Using U(IV) prepared by this method the following aspects were studied: the stability of U(IV) solutions in nitric acid as the functions of nitric acid, hydrazine, and U(IV) concentration; the distribution of U(IV) in 30% TBP in kerosene and in TBP loaded with U(VI) to the plant conditions; the effect of the presence of U(VI) in U(IV) on the distribution of U(IV) in 30% TBP; and the optimum conditions for the effective stripping of plutonium from TBP phase. (auth)

45242 (BNL-50133) INTERATOMIC FORCES IN CHEMICAL REACTIONS. Brookhaven Lecture Series Number 76. Weston, Ralph E. Jr. (Brookhaven National Lab., Upton, N. Y.). July 10, 1968. 13p. Dep. CFSTI.

The transition state or activated complex theory of chemical kinetics is discussed. The theory helps to provide an understanding of how isotopic substitution affects the rate of reaction. Isotope effects are related to changes in vibrational force constants, and therefore can be used as a probe for changes of interatomic forces which take place during reaction. (J.G.B.)

45243 (NP-18010) SOLID-STATE INVESTIGATIONS ON AMERICIUM COMPOUNDS. ter Meer, Nicolaus (Munich Univ. (West Germany)). 1969. 97p. (In German). Dep. CFSTI (U. S. Sales Only).

Thesis.

Topics covered include: discovery of americium, experimental techniques for work with americium and its salts, safety precautions, exhaust air treatment, gloveboxes, removal from radioactive fallout, roentgenographic methods for highly radioactive materials, preparation of pure americium(III) stock solution, preparation of americium(III) salts with organic anions, thermal decomposition in a mass spectrometer, investigations on the Moessbauer effect in compounds of ^{241}Am, and summary of results and survey. (M.C.G.)

45244 (ORNL-tr-2212) PROBABLE CHEMICAL PROPERTIES OF ELEMENT 114. Joergensen, C. K.; Haissinsky, M. Translated by R. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Radiochem. Radioanal. Lett., 1: No. 3, 181-4(1969). 4p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 37945.

45245 (RD/B/M-1390) A REVIEW OF THE THERMAL EXCHANGE OF ISOTOPES BETWEEN CO AND CO_2. Wickham, A. J. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). July 1969. 14p. Dep. CFSTI (U. S. Sales Only).

Work on the thermal exchange reactions in the CO/CO_2 and associated systems, both in the presence and absence of catalytic surfaces, is reviewed. It is concluded that the reactions that occur in the presence of a carbon surface proceed by a different mechanism from those occurring in the gas phase or in the presence of glass, silica, metal, or oxide surfaces. Reactions in silica or pyrex vessels were shown to occur primarily by dissociative or nondissociative absorption of at least one of the reactants on the surface. At higher temperatures the homogeneous reaction becomes more important, especially in CO/CO_2 above 900°C. The kinetics of this system are well understood in situations where interfering surface effects can be eliminated. (auth) (UK)

45246 (UCRL-Trans-10366) SPECTROPHOTOMETRIC STUDY OF THE COMPLEXES OF CERIUM AND URANIDES WITH DIETHYLENETRIAMINEPENTAACETIC ACID. Hafez, Mohamed Badreldin (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). Translated by Ralph L. McElroy for Univ. of California Lawrence Radiation Lab., Livermore, from report CEA-R-3521. 98p. Dep. CFSTI.

Thesis.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 17391.

45247 (Y-1687) DETERMINATION OF THE CRYSTAL SYSTEM AND LATTICE PARAMETERS OF PREVIOUSLY UNREPORTED COMPOUNDS. Holcombe, C. E. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 22, 1969. Contract W-7405-eng-26. 24p. Dep. CFSTI.

Computer programs were developed in BASIC language, for the CEIR 420 teletype computer system, in order to index patterns of cubic, tetragonal, and hexagonal materials whose crystal systems were previously unidentified by analytical methods. (auth)

45248 RADIOCHEMICAL STUDY OF SELF-DIFFUSION AND ISOTOPE EXCHANGE IN AQUEOUS SOLUTIONS. PART IV. THE THEORY OF DETERMINING ISOTOPE EXCHANGE BY ELECTROLYTIC METHOD WITHOUT ANALYTICAL SEPARATION OF COMPONENTS. Gosman, A.; Sedlacek, J. (Technical Univ., Prague). Radiochem. Radioanal. Lett., 1: 383-91 (Sept. 13, 1969).

The general theory of the electrolytic method for determining isotope exchange rate on the basis of the simultaneous electrolytic deposition of both components is presented. (auth)

45249 RADIOCHEMICAL STUDY OF SELF-DIFFUSION AND ISOTOPE EXCHANGE IN AQUEOUS SOLUTIONS. PART V. THE THEORY OF DETERMINING ISOTOPE EXCHANGE BY AN ELECTROLYTIC METHOD WITHOUT ANALYTICAL SEPARATION OF COMPONENTS. Gosman, A.; Sedlacek, J. (Technical Univ., Prague). Radiochem. Radioanal. Lett., 1: 393-400(Sept. 13, 1969).

The general theory of the electrolytic method for determining isotope exchange rate on the basis of the simultaneous electrolytic deposition of both components, when the deposition on the electrode is considered as a one-way reaction of the first order is presented. An analysis of the theory according to sensitivity and applicability is also presented. (auth)

45250 PECULIARITIES OF TRANSFER AND DISSIPATION OF ENERGY IN LUMINESCENT MATERIALS BASED ON POLYPHOSPHORIC ACIDS WITH URANYL AND RARE EARTH IONS. Gaevoi, G. M.; Zhabotinskii, M. E.; Krasilov, Yu. I.; Rudnitskii, Yu. P.; Ellert, G. V.; Kizel, V. A. Izv. Akad. Nauk SSSR, Neorg. Mater., 5: 691-700(Apr. 1969). (In Russian).

The effective transfer of energy from any uranyl ion group in polymolecules completely to the activator is explained by the rapid exchange between these groups and the striving of rare earth ions to enter the surroundings of one of the uranyl ions in such molecules. The decrease in probability of the transfer $UO_2^{2+} \rightarrow Eu^{3+}$ on decrease of the relation H_2O/P_2O_5 is apparently explained by the change in distance between the uranyl and europium ions, occurring because of increased P-O bond constants and valence angles in PO_4^{3-} tetrahedrons. The quenching of the luminescence of uranyl ions and rare earth ions in polyphosphoric acids is stimulated by the presence of OH groups and O-P-O bonds are channels for the transfer of energy. (tr-auth)

45251 THE LIQUID MOLAR VOLUMES IN $ThCl_4$-NaCl SYSTEMS. Oyamada, Ryozo (National Research Inst. for Metals, Tokyo); Yoshida, Susumu. Denki Kagaku, 37: 417-19(June 1969). (In Japanese).

Densities of molten $ThCl_4$-NaCl systems were measured with a silicon thermal balance in an inert atmosphere, and the liquid molar volumes and expansivities were calculated. Negative deviation from additivity in molar volume was found to be about 0.33 mole fraction, which seems to suggest the existence of complex ion $[ThCl_6]^{2-}$. (NSA of Japan)

45252 ENZYMATIC AND RELATED NON-ENZYMATIC REACTION MECHANISMS. PART I. SECONDARY VALENCE FORCE CATALYSIS. RATE AND EQUILIBRIUM CONSTANTS FOR ADDITION OF CYANIDE ION TO N-SUBSTITUTED 3-CARBAMOYLPYRIDINIUM IONS. PART II. SOLVENT DEUTERIUM ISOTOPE EFFECTS ON THE GLYCERALDEHYDE-3-PHOSPHATE DEHYDROGENASE-CATALYZED HYDROLYSIS OF p-NITROPHENYL ACETATE. Lindquist, Robert Nels. Bloomington, Ind., Indiana Univ., 1968. 113p.

Thesis.

Rate and equilibrium constants for 1,4 addition of cyanide ion to

a series of N-substituted 3-carbamoylpyridinium ions were measured in aqueous solution at 25°C. In several cases, products absorbing near 340 mμ were isolated and shown to be, in fact, the 1,4 adducts by nuclear magnetic resonance spectroscopy or mass spectrometry. The 1,4-cyanide adducts of the 3-carbamoylpyridinium ions are not the thermodynamically stable species in alkaline aqueous cyanide solutions at 25°C as shown by the time-dependent loss of the 340 mμ absorption band. Charge-transfer complexation has little effect on the reactivity or affinity of pyridinium ions toward cyanide as evidenced by rate and equilibrium constants for addition of this species to intramolecularly complexed substrates. An increase in ionic strength in the range 0.5 to 3.0 M of the reaction medium increases dissociation constants and decreases second-order rate constants for the addition of cyanide to the 4-position of N-methyl-3-carbamoylpyridinium ion. Solvent deuterium isotope effects on the kinetics of glyceraldehyde-3-phosphate dehydrogenase-catalyzed hydrolysis of p-nitrophenyl acetate in aqueous solution in the pH range 6 to 9 and at 25°C were investigated. Employing enzymes isolated both from rabbit muscle and yeast, it has been established that the rate of enzyme acylation by this ester is decreased 2.5-fold in deuterium oxide compared to water under conditions in which the rate is linearly dependent on hydroxide ion concentration but is independent of the isotopic nature of the solvent under more basic conditions in which the rate is independent of the hydroxide ion concentration. In water, the acylation rate constant is dependent on a basic group, the conjugate acid of which has a pK_a near 8.2; in D_2O this same group has a pK_a near 8.7. This is consistent with an acylation reaction involving the unaided attack of the anionic form of a crucial sulfhydryl residue on p-nitrophenyl acetate within the Michaelis–Menten complex. Closely related behavior is observed for deacylation of the yeast enzyme: the rate is depressed 3-fold by D_2O under conditions of hydroxide ion catalysis but is unaffected by this agent under more basic conditions in which the reaction is pH-independent. Values of pK_a for the conjugate acid of the basic species upon which the reaction depends are 8.8 and 9.3 in water and D_2O, respectively. (Disser. Abstr.)

45253 PROPERTIES OF NIOBIUM AND TANTALUM IN SOLUTIONS. Babko, A. K.; Nabivanets, B. I. (Inst. of General and Inorganic Chemistry, Kiev). Probl. Sovrem. Khim. Koord. Soedin., Leningrad. Gos. Univ., No. 2, 111-28(1968). (In Russian).

The chemistry of Nb and Ta compounds in aqueous solutions is reviewed, particularly the properties of these compounds in acidic solutions, their hydration, solubility, complex formation, and polymerization, pertinent to the theory and to the wet processing of Nb- and Ta- containing raw materials. The data on dissociation constants, solubility, dialysis coefficients, and reaction mechanisms were obtained by methods of spectrophotometry, dialysis, electrodialysis, solubility measurements, ion exchange chromatography, and ion exchange extraction with amines; the studies cover solutions not containing complex forming agents, HCl solutions, H_2SO_4 solutions, fluoride and oxalate solutions, solutions containing hydroperoxide, and solutions in acidified aqueous hydroperoxide, and the mechanism of formation of hydrolytic polymers. A characteristic property of the solutions is the formation of hydrolyzed ions and stable hydrolytic polymers. Equilibrium is defined by the acidic and basic dissociation constants of the amphoteric compounds $NbO(OH)_3$ and $Ta(OH)_5$. Reaction with the complex forming agents causes decomposition of polymers, and Nb polymers decompose more readily than Ta polymers. Complexes are formed by displacement of hydroxyl ions by the complex forming ions, resulting mainly in anionic complexes; formation of cationic forms occurs in presence of hydrogen peroxide and pH values below 1. The stability constants were determined for the hydroxo, oxalate, and sulfate complexes. Complexes of Nb are markedly more stable than complexes of Ta, and this is due to the higher stability of the Nb–O bond compared with the Ta–O bond. (JPRS)

45254 MECHANISM OF FUMARASE AS STUDIED BY ISOTOPES OF CARBON, HYDROGEN, AND OXYGEN UNDER CONDITIONS OF EQUILIBRIUM AND NON-EQUILIBRIUM. Hansen, John Norman. Los Angeles, Univ. of California, 1968. 145p. Thesis.

Kinetic studies of fumarase under initial velocity and equilibrium conditions using isotopes of C, H, and O revealed new aspects of the reaction. Under conditions of equilibrium, ^{18}O exchanged between malate and water 1.6 times more rapidly than ^{14}C exchanged between malate and fumarate. This difference was accentuated in the presence of 50% v/v glycerol, in which ^{18}O exchanged 4.5 times as rapidly as ^{14}C. Also under conditions of equilibrium, tritium exchanged between malate and water 2.5 times more slowly than malate exchanged with fumarate. It was shown by simultaneous enzymic dehydration of deuterated and tritiated malates that the slow tritium exchange at equilibrium is not attributable to an isotope effect. When malate was dehydrated by fumarase in the presence of ^{18}O water, measurements of ^{18}O incorporation into malate during very early times showed that ^{18}O was incorporated into unreacted malate. The same experiment when carried out in the presence of 50% v/v glycerol showed even greater incorporation of ^{18}O. The reaction rate of the initial dehydration was independent of whether it was measured spectrophotometrically, by ^{14}C, deuterium, or tritium. In order for ^{18}O to exchange more rapidly than ^{14}C, the enzyme·malate complex must be capable of hydroxyl exchange with medium water without dissociation of free fumarate. This requires C–O bond breakage to be fairly rapid with respect to the fumarate on-off reaction, which in conjunction with ^{18}O incorporation into unreacted malate during initial enzymic dehydration shows that C–O bond breakage cannot be the rate-limiting step in the reaction. Although tritium exchanged less than half as fast as ^{14}C, the lack of an isotope effect also eliminated C–H bond breakage as the rate-limiting step when substrates are at equilibrium. Theoretical kinetic patterns were derived for the mechanism proposed. Programs for the Olivetti–Underwood Programma 101 to calculate equilibrium exchange rates and Lineweaver–Burk plots are included as well as a Fortran(H) program for least-squares fits to equilibrium exchange data. (Disser. Abstr.)

45255 SECONDARY ISOTOPE EFFECTS AS PHOTOCHEMICAL MECHANISTIC CRITERIA. PHOTOSENSITIZED cis-trans OLEFIN ISOMERIZATION NOT INVOLVING THE OLEFIN TRIPLET STATE. Caldwell, Richard A.; James, Stephen P. (Cornell Univ., Ithaca, N. Y.). J. Amer. Chem. Soc., 91: 5184-6(Aug. 27, 1969).

A study of the isotope effects on the isomerization of 1,2-dichloroethylene with benzophenone gave the following values: $k_2(cis\text{-}C_2H_2Cl_2)/k_2(cis\text{-}C_2HDCl_2) = 1.15 \pm 0.02$ and $k_2(trans\text{-}C_2H_2Cl_2)/(trans\text{-}C_2HDCl_2) = 1.18 \pm 0.02$. The isomerization of 2-butene and 2-bromo-2-butene was also studied. (D.H.M.)

45256 EFFECT OF METAL BINDING ON THE HYDROGEN–TRITIUM EXCHANGE OF CONALBUMIN. Ulmer, David D. (Peter Bent Brigham Hospital, Boston). Biochim. Biophys. Acta, 181: 305-10(May 20, 1969).

The rates of H–T exchange of chicken egg conalbumin and its metal complexes were studied by the gel-filtration technique at pH 8 and 4°C. Apoconalbumin samples were equilibrated with tritiated water until no further uptake of T by the protein occurred: in 0.1 M Tris-HCl at pH 9.5, 4°, maximum tritiation was achieved within 24 hr. Apoconalbumin, tritiated by the procedure described, retained ~225 labeled H atoms after the bulk solvent and T released from rapidly exchanging groups were removed by passage through a Sephadex G-25 column at pH 8. Most of the remaining labeled groups exchanged relatively slowly during the subsequent 24 hr at the end of this period; ~45 hydrogen atoms still remained unexchanged and appeared to constitute an inert "core" which is only gradually depleted over many days. The 225 slowly exchanging groups are thought to be peptide hydrogens, which are conformationally shielded from the solvent. Iron-conalbumin retained ~50 more T atoms than the apoprotein at all times during the course of exchange; both rapidly and slowly exchanging classes of H were affected by metal binding. Manganese- and Cu-conalbumin also exchanged more slowly than the apoprotein, but these metals retarded exchange less than Fe. The effect of Fe on the H–T exchange of human serum transferrin is similar to that observed for conalbumin. These data suggest that the apo- and metalloproteins differ in conformation and that the structure of the latter is more compact. (BBB)

45257 POLAR AND STERIC EFFECTS IN ACYL PHOSPHATE MONOANION AND DIANION REACTIONS. Phillips, David R.; Fife, Thomas H. (Univ. of Southern California, Los Angeles). J. Org. Chem., 34: 2710-14(Sept. 1969).

The rate constants for hydrolysis of a series of aliphatic acyl phosphates were determined at 60°C. Complete pH-rate profiles for three of the derivatives, isobutyryl, trimethylacetyl, and 3,3-dimethylbutyryl phosphate, were obtained as well as the monoanion and dianion hydrolytic rate constants for isovaleryl phosphate. The values of ΔS^* were uniformly close to zero, consistent with the postulated unimolecular mechanism of hydrolysis of acyl phosphates. A decrease in the rate of hydrolysis was observed for the monoanion and dianion reactions as steric bulk and electron donation in the acyl group, as measured by the Taft σ^* constants, were increased. Second-order rate constants for reaction of pyridine with the monoanions and dianions were also correlated with σ^* constants. The ρ^* for k_{pyr} (monoanion) was +2.0 and for k_{pyr} (dianion) was +6.1. Imidazole and morpholine did not catalyze the hydrolysis of trimethylacetyl phosphate or 3,3-dimethylbutyryl phosphate. (auth)

45258 INVESTIGATIONS ON THE STABILITY OF URANYL COMPLEXES OF SUBSTITUTED ACETOACETAMIDES. Kettrup, A.; Specker, H. (Ruhr-Univ., Bochum, Ger.). Z. Anal. Chem., 246: 108-11(July 31, 1969). (In German).

Uranyl ions form chelate compounds with acetoacetamides. The stability constants of these compounds were determined by potentiometric pH-measurements. The variation of the stability constants with substituents of the amide group is interpreted. (auth)

45259 ISOTOPE EFFECT IN SELF-DIFFUSION IN IRON. Walter, Charles Monroe. Evanston, Ill., Northwestern Univ., 1968. 82p.

Thesis.

The isotope effect in self-diffusion was measured in the δ, γ, and α phases of iron using a new isotope pair, $^{52}Fe-^{59}Fe$. The isotope effect data together with measurements taken on the effect of cobalt solute additions on iron self-diffusion were used to deduce the most likely mechanism of self-diffusion in all three iron phases. The strength of the isotope effect in bcc δ-Fe was found to be $E = 0.337 \pm 0.007$ and if a vacancy diffusion mechanism was assumed $\Delta K = 0.464 \pm 0.009$. The best value of E for fcc γ-Fe was 0.530 ± 0.015 giving $\Delta K = 0.680 \pm 0.020$ for a vacancy mechanism. A value of $E = 0.46 \pm 0.04$ was found in the bcc α-phase with a corresponding $\Delta K = 0.63 \pm 0.06$ if a vacancy mechanism was assumed. Because of experimental limitations the value of E in the α-phase is rather uncertain and care must be exercised in attaching any real significance to the difference between it and the value obtained for δ-Fe. The isotope effect results are consistent with a vacancy mechanism in γ-Fe. By applying Lidiard's theory on the effect of solutes on self-diffusion the impurity correlation factor f_1 for Co in Fe was found to be $f_1 = 0.81 \pm 0.01$ in δ-Fe and $f_1 = 0.83 \pm 0.01$ in α-Fe suggesting that the same diffusion mechanism was operating in both of these bcc phases. This observation made it possible to eliminate divacancies as a likely mechanism and left only vacancy or interstitialcy diffusion as probable mechanisms. Although it was not possible to make a choice between these two mechanisms, the possibilities were narrowed to only two for the first time in a bcc metal. Suggestions were made for future experiments that should deduce which of the two mechanisms actually operates. (Disser. Abstr.)

45260 THE BEHAVIOR OF CEROUS IONS AT VERY LOW CONCENTRATION. Suzuki, Shin (Tohoku Univ., Sendai); Mitsuji, Toshikazu. Nippon Kagaku Zasshi, 90: 677-9(July 1969). (In Japanese).

The behavior of cerous ions at very low concentrations ($\sim 10^{-11}$ moles/l) was investigated by using filtration and paper electrophoresis. The cerous ions at this concentration were hydrolyzed at pH ≅ 6. From these results, the solubility product of cerous hydroxide was calculated to be 10^{-35}. This value was much smaller than the value calculated from data for the macroquantity (1.4×10^{-20}). This anomalous behavior of cerous ions in its very low concentration can be explained only by the formation of the radiocolloids. (NSA of Japan)

45261 MIXED OXIDE OF THORIUM AND URANIUM MONOPHASED OXIDATION CATALYST. Bressat, Rene; De Calmes, Alain; Claudel, Bernard; Trambouze, Yves (to Commissariat a l'Energie Atomique). U. S. Patent 3,459,682. Priority date Dec. 8, 1964, France.

A highly reactive monophase oxidation catalyst consisting of a mixed oxide of Th and U was prepared by heating a complex oxalate or mixed oxalate of U and Th up to a decomposition temperature of from 400 to 500°C. (Offic. Gaz.)

45262 SEPARATION OF HIGH-PURITY YTTRIUM SALT FOR FLUORESCENT MATERIAL FROM CRUDE RARE EARTH MIXTURE BY ION EXCHANGE. Yajima, Seishi; Sasaki, Kaoru (Tohoku Univ., Sendai). Kogyo Kagaku Zasshi, 72: 1213-18 (June 1969). (In Japanese).

High-purity Y_2O_3 for fluorescent material was prepared from a crude rare earth mixture by replacement chromatography using EDTA solution as eluant. The relation between yield of Y_2O_3 and elution conditions was investigated. The neighboring rare earths, such as Dy and Tb, which were present in Y fractions, were determined by mass spectrography and radioactivation analysis, respectively. From the analytical results, the tailing of both the elements was investigated. Y_2O_3 samples obtained from Y fraction were mixed with a set weight ratio of Eu_2O_3 and the mixtures were made into solid solutions. The brightness of the 6113 Å fluorescence of these solid solution specimens excited by 3650 Å radiation was measured, and the effect of the neighboring rare earths on the brightness was investigated. From the experimental results, it was found that the following elution conditions: (flow rate, 2 ml/min/cm^2; retaining ions, Cu^{2+} (80%) + H^+ (20%); and band ratio, 2) were so favorable that highly pure Y_2O_3 (99.9%) was obtained with more than 95% yield. (NSA of Japan)

45263 STRUCTURAL STUDY OF AMMONIUM URANYL PENTAFLUORIDE. Brusset, Henry; Gillier-Pandraud, Helene; Nguyen-Quy-Dao (Laboratoire de Recherches de Chimie Systematique, Paris, Faculte des Sciences, Paris). Acta Crystallogr., Sect. B, 25: 67-73(1969). (In French).

$(NH_4)_3UO_2F_5$ is monoclinic, space-group Cm with 12 molecules in the unit cell of dimensions: $a = 29.22$, $b = 9.48$, $c = 13.51$ Å; $\beta = 136° 07'$. The pseudo unit cell is orthorhombic: $a' = 9.74$, $b' = 9.48$, $c' = 9.38$ Å. Twinning was observed frequently. One type of twin is described. The structure was mined from Patterson projection and Fourier syntheses. Refinement was made by Fourier syntheses and least-squares methods. The UO_2F_5 group has the shape of a lightly distorted pentagonal bipyramid. The bond lengths of U–O and U–F are 1.9 ± 0.2 Å and 2.2 ± 0.2 Å respectively. (auth) (Denmark)

45264 IONIZATION CONSTANTS OF T_2O AND D_2O AT 25° FROM CELL EMF'S. INTERPRETATION OF THE HYDROGEN ISOTOPE EFFECTS IN EMF'S. Goldblatt, Maxwell; Jones, Wesley M. (Los Alamos Scientific Lab., N. Mex.). J. Chem. Phys., 51: 1881-94(Sept. 1, 1969).

The ionization constants of T_2O and D_2O were determined to be 6.1×10^{-16} and 1.43×10^{-15} at 25°, corresponding to $K(H_2O)/K(T_2O) = 16.4$ and $K(H_2O)/K(D_2O) = 7.1$ (concentrations in aquamolalities m', moles of solute per 55.51 moles of isotopic water). Emf's were measured at 25° with X = H, D, and T for cells of the types: $Pt-X_2(p)\,|NaOX\,(m_2') + NaCl(m_3')\,|AgCl-Ag$ and $Pt-X_2\,(p)\,|XCl(m_1')\,|AgCl-Ag$; $m_1' = m_2' = m_3' = 0.1$. The isotope differences $[E°(isotope)-E°\,(H_2O)]$ in the alkaline cell are 45.8 ± 0.5 mV for D_2O and 65.4 ± 0.3 mV for T_2O. In the acid cell the differences are -4.4 ± 0.1 mV for D_2O and -6.4 ± 0.2 mV for T_2O. Published data on the H_2O-D_2O emf isotope effects from 5° to 50° in alkaline and acid cells are correlated with spectral and structural information by methods similar to those used in the treatment of vapor-pressure isotope effects. These methods and the H_2O-D_2O data are used to predict H_2O-T_2O isotope effects in emf's and a value of $K(H_2O)/K(T_2O)$ which agree satisfactorily with experiment. Free energies of transfer of NaCl from D_2O to H_2O and from T_2O to H_2O are discussed. (auth)

45265 THERMOCHEMICAL STUDIES OF HYDROLYTIC REACTIONS. 8. A RECALCULATION OF CALORIMETER DATA ON URANYL HYDROLYSIS. Arnek, Robert; Schlyter, Kurt (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 22: 1331-3(1968).

The calorimeter data reported in 1962 on uranyl hydrolysis in the medium 3M $NaClO_4$ at 25°C were recalculated by means of the computer program LETA-GROPVRID. The following results were obtained (deviations 3σ): $2\,UO_2^{2+} + 2\,H_2O \rightleftharpoons (UO_2)_2(OH)_2^{2+} + 2H^+$, $\Delta H°$, kcal = 9.5 ± 0.1 and $\Delta S°$, eu = 4.3 ± 0.3; $3\,UO_2^{2+} + 5\,H_2O \rightleftharpoons (UO_2)_3(OH)_5^+ + 5H^+$, $\Delta H°$, kcal = 24.4 ± 1.5 and $\Delta S°$, eu = 6 ± 5. (auth)

45266 STERIC ISOTOPE EFFECTS. III. THE DEUTERIUM ISOTOPE EFFECT IN THE RACEMIZATION OF (-)-1,1'-BINAPHTHYL-2,2'-d_2. Carter, Robert E.; Dahlgren, Lennart (Univ. of Goteborg. Chalmers Inst. of Tech., Goteborg). Acta Chem. Scand., 23: 504-14(1969).

(-)-1,1'-Binaphthyl-2,2'-d_2 was synthesized and its rate of racemization compared with that of the protium compound at temperatures between 20 and 65°C. The isotopic rate ratio (k_D/k_H) was found to vary from 1.20 to 1.14 over this range, and a least-squares treatment of a plot of $\ln(k_D/k_H)$ vs 1/T gave values for $\Delta\Delta H^{\neq} = \Delta H_H^{\neq} - \Delta H_D^{\neq} = 0.27 \pm 0.14$ kcal/mole and $\Delta\Delta S^{\neq} = 0.54 \pm 0.43$ e.u. The results are discussed in terms of Bartell's theory of steric isotope effects and from the point of view of force constant changes between initial and transition states which lead to a change in zero-point energy. It is emphasized that these are two equivalent descriptions of the same vibrational phenomenon. (auth) (Denmark)

45267 SOLVENT DEUTERIUM ISOTOPE EFFECTS ON ACID-BASE REACTIONS. PART IV. LYONIUM ION-CATALYZED HYDROLYSIS OF TERTIARY BUTYL ACETATE IN ISOTOPICALLY DIFFERENT WATERS. Salomaa, Pentti (Univ. of Turku, Finland). Acta Chem. Scand., 23: 713-14(1969).

A semiempirically calculated value of 2.33 for k_D/k_H is in agreement with the value of 2.34 ± 0.05 given by the experimental results obtained for the catalyzed $A_{AL}1$ hydrolysis and uncatalyzed $B_{AL}1$ hydrolysis in light water. (Denmark)

45268 HYDROGEN ISOTOPE EFFECTS IN THE BROMINATION OF 2-METHYL-1,3,5-TRIETHYLBENZENE AND 2,4-DIMETHYL-1,3,5-TRIETHYLBENZENE. Nilsson, Ake; Olsson, Kare (Univ. of Goteborg. Chalmers Inst. of Tech., Goteborg). Acta Chem. Scand., 23: 7-13(1969).

The substrates, prepared by direct methods from 1,3,5-triethylbenzene, were brominated by molecular bromine in dimethylformamide. Competitive experiments with partially deuterated compounds gave the isotopic rate ratios $k_D/k_H = 0.95 \pm 0.03$ and $k_D/k_H = 0.86 \pm 0.03$ for the bromination of 2-methyl-1,3,5-triethylbenzene and 2,4-dimethyl-1,3,5-triethylbenzene, respectively, at −20°C. (auth) (Denmark)

45269 POTENTIOMETRIC STUDY OF FLUORIDE COMPLEXES OF URANIUM(IV) AND URANIUM(VI) USING THE U(VI)/

U(IV) REDOX COUPLE. Grenthe, Ingmar; Varfeldt, Jens (Univ. of Lund, Sweden). Acta Chem. Scand., 23: 988-98(1969).

The stability constants for the formation of fluoride complexes of U(IV) and U(VI) were determined at a temperature of 25.00°C in solutions containing 0.60 M $HClO_4$ and 3.40 M $NaClO_4$ as ionic medium. The measurements were made using a potentiometric technique where the variation of the redox potential for the U(VI)/U(IV) couple with the ligand concentration was used for the determination of the various stability constants. (auth) (Denmark)

45270 CRYSTAL STRUCTURE OF $[(UO_2)_2(OH)_2Cl_2(H_2O)_4]$. Aberg, Martha (Royal Inst. of Tech., Stockholm). Acta Chem. Scand., 23: 791-810(1969).

The structure of the uranyl hydroxide chloride $[(UO_2)_2(OH)_2Cl_2(H_2O)_4]$ was determined from three-dimensional x-ray data. The crystals are monoclinic and the space group is No. 14: $P2_1/n$. The unit cell contains four formula units (eight uranium atoms) and has the dimensions a = 17.743 Å, b = 6.136 Å, c = 10.725 Å and $\beta = 95.52°$. The structure is built up from discrete, uncharged molecules containing two linear uranyl groups, each of which is surrounded by one chlorine and four oxygen atoms forming an irregular planar pentagon. The two uranium atoms in a molecule are linked through a double OH bridge and the dimers are held together by hydrogen bonds. (auth) (Denmark)

45271 NEW SUPERLATTICE REFLECTIONS OF U_4O_9. Masaki, Norio; Doi, Kenji (Japan Atomic Energy Research Inst., Tokai). Acta Crystallogr., Sect. B, 24: 1393-4(1968).

Neutron reflexions corresponding to an $8 \times a_0 (a_0 = 5.44$ Å) cubic superlattice were observed for a U_4O_9 single crystal at room temperature and at 120°C. (auth) (Denmark)

45272 ION-PAIR REACTIVITY IN ISOTOPIC EXCHANGE REACTIONS. I. LITHIUM CHLORIDE IN ACETONE AS SOLVENT. Beronius, Per (Univ. of Umea, Sweden). Acta Chem. Scand., 23: 1175-80(1969).

Second-order rate constants, k, for the exchange of ^{36}Cl between p-nitrobenzyl chloride ($p\text{-}NO_2BzCl$) and lithium chloride in anhydrous acetone were measured at 25°C for a range of concentrations of the ionic reactant. The data were analyzed by means of the Acree equation, $k = k_i\alpha + k_m(1-\alpha)$, where k_i and k_m are rate constants for the reaction of free ions (Cl^-) and ion-pairs (LiCl), respectively, and α the degree of dissociation of the salt. Values of α were evaluated from ion-pair dissociation constants obtained by means of the Shedlovsky method for different choices of the distance of closest approach of Li^+ and Cl^-. The k_m-values found are less than 1% of k_i indicating that the ion-pairs are kinetically inactive. Assuming k_m to be zero, the dependence of the rate constant, k on the salt concentration has been employed to calculate the ion-pair dissociation constant. The value 2.83×10^{-6} obtained is to be compared with the dissociation constant 3.39×10^{-6} according to conductivity data. (auth) (Denmark)

45273 THERMAL DIFFUSION IN ISOTOPIC $^{16}O_2$–$^{18}O_2$. Mathur, B. P.; Watson, W. W. (Yale Univ., New Haven). Contract AT(30-1)-2726. J. Chem. Phys., 51: 2210-14(Sept. 1, 1969). (YALE-2726-536).

The isotopic thermal diffusion factor α_0 was measured for a 90% $^{16}O_2$–10% $^{18}O_2$ symmetrical mixture, using both the conventional two-bulb apparatus and the trennschaukel. The values are in the average temperature range of 125 to 440°K. It was found that α_0 is negative below about 135°K, while at higher temperatures there is good agreement with the literature values ($\alpha_0 = 0.45$ at 450°K). Theoretical calculations according to the Chapman–Enskog theory using an Exp-6 potential ($\alpha = 17$, $\epsilon/k = 132.0$°K) agree well with the experimental values in the temperature range 260 to 440°K. At low temperatures the agreement is rather poor. Since even at 78°K as many as five rotational states are excited in this molecule, inelastic collisions must play an important role over the entire temperature range. At our low temperatures, with a fair fraction of the gas at 78°K, the possible incipient polymerization in O_2 may, to some extent, be responsible for the negative values of α_0. (auth)

45274 KINETICS OF THE HOMOGENEOUS EXCHANGE REACTION $^{12}C^{18}O + {}^{13}C^{16}O \rightleftharpoons {}^{13}C^{18}O + {}^{12}C^{16}O$. SINGLE-PULSE SHOCK-TUBE STUDIES. Bar-Nun, Akiva; Lifshitz, Assa (Hebrew Univ., Jerusalem). J. Chem. Phys., 51: 1826-33(Sept. 1, 1969).

The isotopic exchange reaction between two CO molecules was studied under homogeneous conditions in a single-pulse shock tube at high dilution in argon within the 2000 to 2675°K temperature range. From a total of 100 shocks, run at varying initial pressures and compositions, the following rate law was derived: rate of exchange $= k_b[CO]^{1.43}[Ar]^{0.55}$, where $k_b = 10^{14.36\pm0.43} \exp\{-(76 \pm 5) \times 10^3 / RT\}$ cc $mole^{-1} \cdot sec^{-1}$. The possibility of a chain mechanism was ruled out. A two-step mechanism composed of a vibrational excitation step and an atom-switching step is proposed. It was found that exchange occurs at high probability when one of the CO molecules is elevated to the 7th to 10th vibrational level before colliding with another CO molecule. A dipole interaction stabilizing the transition state is proposed in explanation of the relatively low activation energy of this exchange reaction. Two alternative reaction systems are described, and the corresponding rate constants are computed and compared with the experimental results. (auth)

45275 CRYSTAL STRUCTURE OF RUBIDIUM HEXAFLUOROPROTACTINATE(V), $RbPaF_6$. Burns, John H.; Levy, Henri A.; Keller, O. Lewin Jr. (Oak Ridge National Lab., Tenn.). Acta Crystallogr., Sect. B, 24: 1675-80(1968).

The crystal structure of $RbPaF_6$ was determined from three-dimensional Ag Kα x-ray data by Patterson and Fourier methods. Crystals are orthorhombic with a = 8.0483 Å, b = 12.025 Å, c = 5.8608 Å, space group Cmma. After least-squares refinement of positions and anisotropic thermal parameters, the R index based on F was 0.048. Each Pa atom is bonded to eight F atoms in a dodecahedron having D_{2d}–$\bar{4}2m$ symmetry. Dodecahedra share edges to form chains along the a axis; in this feature, the structure resembles that of K_2ZrF_6. The Pa–F bond lengths are 2.34 Å and 2.09 Å for F atoms in the shared and unshared edges, respectively. The Rb atoms are between chains and have ten F neighbors at distances from 2.81 Å to 3.17 Å. The structure is contrasted with similar compounds of Nb and Ta. (auth)

45276 CRYSTAL STRUCTURE OF β-PROTACTINIUM PENTABROMIDE. Brown, D.; Petcher, T. J.; Smith, A. J. (Sheffield Univ., Eng.). Acta Crystallogr., Sect. B, 25: 178-82(1969).

Protactinium pentabromide crystallizes in two distinct modifications. A three-dimensional structure analysis of the β form (final R = 9.05%) indicated it to be essentially isostructural with uranium pentachloride. The molecular Pa_2Br_{10} units are bis-octahedral with symmetric bromine bridging (in contrast to U_2Cl_{10}), and are formed by the protactinium atoms occupying one fifth of the octahedral holes of a closely packed bromine lattice. The monoclinic unit cell of β-$PaBr_5$ has a = 8.385, b = 11.205, c = 8.950 Å, and $\beta = 91.1°$. The structural relationship of β-$PaBr_5$ with other pentahalides and with other protactinium compounds is discussed. (auth)

45277 STRUCTURE OF SOME ALKALINE-EARTH METAL URANATES. Loopstra, B. O.; Rietveld, H. M. (Reactor Centrum Netherland, Petten, Netherlands). Acta Crystallogr., Sect. B, 25: 787-91(1969).

The structures of $CaUO_4$, $SrUO_4$ (orthorhombic), $BaUO_4$, Ca_2UO_5, Sr_2UO_5, Ca_3UO_6, and Sr_3UO_6 were, where necessary, further determined and refined from neutron powder diffraction data. Least-squares parameters were obtained by fitting a calculated profile to the observed data. The standard deviations in the atomic positions varied with the number of independent structure parameters from 0.0007 Å for $CaUO_4$ to 0.029 Å for Sr_3UO_6. (auth)

45278 SOLVENT EXTRACTION AND POTENTIOMETRIC STUDY OF FLUORIDE COMPLEXES OF THORIUM(IV) AND URANIUM(IV). Noren, Bertil (Univ. of Lund, Sweden). Acta Chem. Scand., 23: 931-42(1969).

The properties of a fluoride membrane electrode were studied. The electrode was employed for an investigation of the fluoride complexes formed by Th(IV) and U(IV) in 4.00 M perchloric acid solution and at a temperature of 20.00°C. The Th(IV) complexes were also studied in the same medium by means of solvent extraction measurements. The results obtained by the two methods were compared. The stability constants determined for Th(IV) and U(IV) were compared with those previously obtained for Zr(IV), Hf(IV), and Np(IV). (auth) (Denmark)

45279 NOTE ON THE STRUCTURES OF $M(IV)P_2O_7$ (M(IV) = Ge, Zr, AND U). Hagman, Lars-Ove; Kierkegaard, Peder (Univ. of Stockholm). Acta Chem. Scand., 23: 327-8(1969).

Several members of the series $M(IV)P_2O_7$ compounds were synthesized and characterized by x-ray techniques. The single-crystal rotation and Weissenberg photographs of GeP_2O_7, ZrP_2O_7, and UP_2O_7 revealed the type of superstructure assumed by Novotny and co-workers (Monatsh., 94: 956(1963)). (Denmark)

45280 DISSOCIATION CONSTANT OF 3,5-DINITROPHENOL IN DEUTERIUM OXIDE AT 25°C. Robinson, R. A. (State Univ. of New York, Binghamton). J. Chem. Eng. Data, 14: 247-8(Apr. 1969).

If data for the dissociation constant of a number of nitrophenols measured in ordinary water and deuterium oxide are plotted as the difference in pK, ΔpK = pK (in D_2O) – pK (in H_2O), against pK (in H_2O) there is a linear increase in ΔpK with increasing value of pK (in H_2O). The point for 3,5-dinitrophenol on such a plot, however, seems to be too high by as much as 0.07 in ΔpK. The pK value of this phenol in water and D_2O were redetermined by a spectrophotometric method. The dissociation constant of 3,5-dinitrophenol in deuterium oxide at 25°C was found to be 4.95×10^{-8} (molality scale), pK = 7.305 to confirm the earlier observation that the difference between the pK value of this phenol in

heavy water and in ordinary water is large compared with that found for other nitrophenols. (BBB)

45281 AN ISOPIESTIC VAPOR PRESSURE STUDY OF THE SYSTEM POTASSIUM CHLORIDE–SODIUM CHLORIDE IN DEUTERIUM OXIDE SOLUTION AT 25°. Robinson, R. A. (State Univ. of New York, Binghamton. National Bureau of Standards, Washington, D. C.). J. Phys. Chem., 73: 3165-6(Sept. 1969).

Osmotic coefficients are given for KCl, NaCl, and NaCl–KCl mixture in heavy water solution (all results are given in terms of aquamolality, moles of salt in 55.51 moles of solvent). It was concluded that there is no detectable difference (within the limits of experimental error) in the behavior of KCl–NaCl mixtures in ordinary water and in deuterium oxide, provided that the results are expressed on the aquamolality scale. (D.H.M.)

45282 ELLIPSOMETER STUDIES OF PLUTONIUM OXIDATION. Larson, D. T.; Cash, D. L. (Dow Chemical Co., Golden, Colo.). Contract AT(29-1)-1106. J. Phys. Chem., 73: 2814-20(Sept. 1969).

An ellipsometer–high vacuum system was used to investigate the kinetics of initial oxidation of plutonium stabilized in the Δ phase with 1.0 wt % gallium. "Clean" plutonium surfaces were prepared in a vacuum chamber using argon ion bombardment. The prepared surfaces were oxidized thermally in 5.0×10^{-2} Torr of oxygen in a temperature range of 28 to 90°C. Oxide thickness as a function of time was calculated from the ellipsometer measurements. These low-temperature oxidation data were fit to the parabolic equation $d^2 = kt + C$; where d is film thickness, t is oxidation time, and k is the rate constant. From values of k for the various oxidation temperatures and by the use of the Arrhenius equation, the activation energy was calculated to be 30 kcal/mol. The major oxide found under the experimental conditions used was identified by x-ray diffraction as PuO_2 with a high (111) orientation. (auth)

45283 STUDIES ON CALCIUM URANATES. Brisi, Cesare; Montorsi Appendino, Margherita (Politecnico, Turin). Ann. Chim. (Rome), 59: 400-11(May 1969). (In Italian).

Products obtained by calcination of calcium oxide and uranium oxides in air were studied. In most instances solutions of calcium nitrate and uranyl nitrate were mixed, evaporated to dryness, and the residue heated in air, the temperature increasing from 900 to 1300°C. In other instances calcination was done directly from a mixture of U_3O_8 and CaO or $CaCO_3$. Chemical and x-ray diffraction analysis of the products was performed. Five uranates were identified corresponding to the formulas Ca_3UO_6, Ca_2UO_5, $CaUO_4$, $Ca_3U_2O_{11}$, and CaU_2O_7. Tricalcium uranate showed 2 different crystalline modifications, one of which was probably metastable. The products of Ca_3UO_6, Ca_2UO_5, and $CaUO_4$ were stable up to at least 1300°C; monocalcium uranate, however, lost oxygen in the course of heating to this temperature $Ca_2U_2O_{11}$ decomposed at 1110°C into molecular oxygen, $CaUO_4$, and a phase corresponding to the formula $Ca_3U_5O_{16.5}$. This phase decomposed at 1250°C into $CaUO_4$ and a phase, with fluorite structure, of formula $(Ca_{1-x}U_x)O_{\sim 2}$, where x had a value near 0.67. CaU_2O_7 also lost oxygen at about 1130°C giving the fluorite phase. In the zone of the system rich of U a new phase was found, corresponding to the formula $CaU_5O_{15.4}$. This phase decomposed at about 1080°C into molecular oxygen, U_3O_8, and CaU_2O_7. A diagram is given which shows the equilibrium conditions for the various phases of the system $CaO–UO_2–O_2$ in air, between 900 and 1300°C. (BBB)

45284 PHASE DIAGRAMS OF SOME SODIUM AND POTASSIUM SALTS IN LIGHT AND HEAVY WATER. Holmberg, Karl Erik (Aktiebolaget Atomenergi, Studsvik, Sweden). Acta Chem. Scand., 23: 467-77(1969).

Phase diagrams for fluorides, chlorides, bromides, iodides, nitrates, sulfates, and carbonates of sodium and potassium with D_2O and H_2O were determined in the range from eutectic temperature to 60°C. Generally the relative solubility is less in D_2O, but there are some exceptions in cases of a hydrate as the solid phase. The freezing point depression for freezing of ice is often somewhat smaller in the case of D_2O. (auth) (Denmark)

45285 SOLUTION OF U_3O_8 WITH SO_2. Saracco, Giovanni Battista; Piccinini, Norberto (Politecnico, Turin). Ann. Chim. (Rome), 58: 1491-1506(1968). (In Italian).

A technique and apparatus are described that were used to dissolve uranium oxide under oxidizing conditions. The chemical reactions involved in the process are outlined. Solution of U_3O_8 in aqueous suspension was carried out by treating it with SO_2 and air, with and without $Fe_2(SO_4)_3$ as oxidizer. Experiments to determine optimal values for the parameters affecting the reaction are described, and qualitative considerations as to the following 4 principal findings are stated: the existence of a transient period, the existence of a reaction period during which the reaction rate remains steady, the existence of a maximum value of this rate when the ratio α = air/SO_2 changes, and the displacement of this maximum value towards composition of the gaseous flow, which is richer in SO_2 when the amount of present $Fe_2(SO_4)_3$ increases. (BBB)

45286 KINETICS OF ASCORBIC ACID DECOMPOSITION IN HEAVY WATER. Huettenrauch, R. (VEB Jenapharm, Jena, Ger.). Pharmazie, 23: 284(May 1968). (In German).

Ascorbic acid was dissolved in H_2O and D_2O to make 10% solutions; the pH was adjusted to 2.15, 5.75, and 7.60, and the samples were sealed into vials without treatment with inert gases. The solutions were heated at 50°C, 70°C, and 90°C, and the decomposition followed by oxidimetric titrations. First-order reaction rate constants were determined and the isotope effect calculated. At pH 2.15, k_H/k_D is 1.43 at 323°K, 1.72 at 343°K, and 1.61 at 363°K. At pH 5.75, k_H/k_D is 1.00 at 323°K, 1.70 at 343°K, and 1.48 at 363°K. At pH 7.60, k_H/k_D is 1.91 at 323°K, 1.91 at 343°K, and 1.62 at 363°K. The rate change is attributed to exchange of -OH protons of the ascorbic acid with D_2O, followed by a lowered reaction rate, and lowered dissociation in D_2O of acids in general. (BBB)

45287 REDUCTION OF URANIUM TETRAFLUORIDE WITH MAGNESIUM. de Freitas, Clauer Trench (Instituto de Energia Atomica, Sao Paulo, Brazil). Metalurgia (Sao Paulo), 24: 131-7 (Feb. 1968). (In Portuguese).

Yields of U metal obtainable by the reaction $UF_4 + 2Mg \rightarrow U + 2MgF_2$ vary between 55 and 93%. In a search for optimum yields, 26 reactions were carried out in pressure vessels able to stand high pressures and temperatures up to 1350°C. Graphite crucibles, lined with a 2-mm layer of sand, were inserted into these pressure vessels. Starting materials were UF_4 made in Canada (3.2 g/cm^3 density) and UF_4 made in Germany (2.1 g/cm^3 density) and finely granulated Mg from England. The materials were mixed for one hour in a propylene cylinder by an electric mixer of 86 rpm. Various charges were made in which Mg exceeded its stoichiometric value from 2.5 to 10%. In 3 experiments the reaction course was controlled thermoelectrically with a Cromel-Alumel couple; in 23 it was controlled acoustically. Since noise intensity reflects reaction velocity, the course of reaction was oscillographically recorded and more clearly observed than by thermoelectric means. Numerous tabulated reaction data allow the following conclusions: increasing the Mg excess from 2.5 to 10.0% improves the U yield from 90 to 91%; increasing the charge density from 2.9 to 3.0 g/cm^3 (by compacting) increases the U yield from 90 to 91% (a further increase to 3.3 g/cm^3 (by briquetting) yields 97%); rapid temperature increases and higher reaction starting temperature improved the U yield, 4.0°C/min and 650°C yielded 86% and 10.0°C/min and 700°C yielded 91%; and better yields were obtained with Canadian UF_4 than with the German product. (F.J.W.)

45288 DISSOCIATION OF DEUTERIOCARBONATE ION IN DEUTERIUM OXIDE FROM 5 TO 50°. Paabo, Maya; Bates, Roger G. (National Bureau of Standards, Washington, D. C.). J. Phys. Chem., 73: 3014-17(Sept. 1969).

Electromotive force measurements of cells with deuterium gas electrodes and silver–silver chloride electrodes were used to determine the acidic dissociation constant of deuteriocarbonate ion (DCO_3^-) in deuterium oxide from 5 to 50°C at intervals of 5°. In addition to the dissociation constant, the standard changes of enthalpy, entropy, and heat capacity for the dissociation process at 25°C were obtained. The isotope effect, pK(in D_2O)–pK(in H_2O), for bicarbonate ion is 0.748 at 25°C and decreases with increasing temperature. This value is significantly higher than is found for stronger acids. The entropy of ionization in deuterium oxide is smaller than that in water by 6 $J°K^{-1}$ mol^{-1}; this difference is the same as has been found for other weak acids for which isotope effects have been determined. (auth)

45289 DISPROPORTIONATION OF THE TECHNETATE ION IN AQUEOUS ALKALINE MEDIA. AN ELECTROCHEMICAL STUDY. Kissel, George; Feldberg, Stephen W. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 73: 3082-8 (Sept. 1969).

A study was made to elucidate the primary reduction process when pertechnetate ion is electrochemically reduced in alkaline media. Using the techniques of coulometry (at controlled potential), chronoamperometry, and double potential step chronoamperometry it was demonstrated that technetate ion is produced at the electrode surface when gelatin is present in solution and then undergoes rapid disproportionation. The dependence of the disproportionation rate constant on ionic strength confirms that the reacting species is doubly charged. The small dependence on temperature and pH (in the alkaline region) suggests that the kinetics are proceeding near the diffusion-controlled limit. The rate constant k (1.5×10^9 l. mol^{-1} sec^{-1}), though considerably lower than the commonly accepted limiting value of 10^{10} l. mol^{-1} $sec,^{-1}$ is not unreasonable when the charges of the reacting ions are considered. (auth)

45290 SULPHATE COMPLEXES OF NEPTUNYL(VI), AND A COMPARISON OF THE STRENGTH OF CORRESPONDING

URANIUM AND NEPTUNIUM COMPLEXES IN AQUEOUS SOLUTION. Ahrland, Sten; Brandt, Lars (Univ. of Lund, Sweden). Acta Chem. Scand., 22: 1579-89(1968).

The sulfate complexes of the neptunyl(VI) ion were studied at 21°C in a 1 M perchlorate medium, the acidity of which was 0.20 or 1.00 M. A solvent extraction method was used, the quantity measured being the distribution of neptunium between the aqueous solution and a solution of dibutyl phosphate in carbon tetrachloride. Within the range of ligand concentration measured ($[SO_4^{2-}] \leq 65$ mM), only the two complexes NpO_2SO_4 and $NpO_2(SO_4)_2^{2-}$ are formed in the aqueous phase; there is no trace of hydrogen sulfate complexes. Stability constants, valid under comparable conditions, were collected for the fluoride and sulfate complexes of uranium(IV), neptunium(IV), uranyl(VI), and neptunyl(VI), and also for the hydroxide complexes of the first two acceptors mentioned. On the whole, the stabilities follow the trend to be expected if the bond between the ligand and the central ion is of an essentially electrostatic character, but very striking exceptions to this rule also occur. These were interpreted as presumably connected with differences in the hydration shell between uranium and neptunium ions. (auth) (Denmark)

45291 KINETICS OF HYDROGEN ISOTOPIC EXCHANGE BETWEEN HYDROXYLIC AND THIOHYDRILIC GROUPS IN THE GAS PHASE. Denisov, G. S.; Ryl'tsev, E. V.; Tokhadze, K. G. Vestn. Leningrad. Univ., No. 4, Ser. Fiz. Khim., No. 1, 92-5(Feb. 1969). (In Russian).

The kinetics of hydrogen isotopic exchange in gaseous mixtures of methanol and methanethiol were studied by means of infrared spectroscopy. The process was found to be trimolecular, involving two alcohol and one thiol molecules. The reaction slowed down upon the addition of a buffer gas. (auth)

45292 UNUSUAL INFLUENCE OF NITROGEN ON RATES OF ANION FORMATION. HYDROGEN–DEUTERIUM EXCHANGE OF PYRIDINE AND THE DIAZINES. Zoltewicz, John A.; Grahe, Gerwalt; Smith, Craig L. (Univ. of Florida, Gainesville). J. Amer. Chem. Soc., 91: 5501-5(Sept. 24, 1969).

Rates of hydrogen–deuterium exchange of pyridine (I), pyrimidine (II), pyridazine (III), and pyrazine (IV) in CH_3OD-CH_3ONa at 164.6°C were obtained by an NMR method. Relative rates for I at positions 2,6:3, 5:4 are 1.0:9.3:12, for II at 2:4,6:5 are 1.0:3.2:48, and for III at 3,6:4,5 are 1.0:14. Log partial rate factors for nitrogen are ortho, 1.31; meta, 2.43; para, 2.46. Activation at a center ortho to nitrogen is less than at a meta or para position. Exchange is believed to take place by simple deprotonation reactions. The unusual acidity pattern may be the result of two reinforcing factors. They are (1) pair–pair electron repulsion between the carbanion and nitrogen and (2) decreased s character in the ortho CH bond associated with an increased endo ring angle. (auth)

45293 SOLVOLYSIS, EXCHANGE, AND ISOMERIZATION OF 4,4'-DIMETHYLBENZHYDRYL THIOCYANATE IN 95 PERCENT AQUEOUS ACETONE. Ceccon, A.; Fava, A.; Papa, I. (Univ., Padua, Univ., Pisa, Italy). J. Amer. Chem. Soc., 91: 5547-50(Sept. 24, 1969).

In 97% aqueous acetone 4,4'-dimethylbenzhydryl thiocyanate solvolyzes while it isomerizes. The solvolytic reaction displays common ion rate depression indicating that free carbonium ion intermediates are captured by the solvent. An analysis of the solvolytic and isotopic exchange rate, k_s and k_{ex}, with changing the concentration of the added common ion, SCN^-, shows that the sum $k_s + k_{ex}$ remains constant and equal to the undepressed solvolytic rate, k_s^0. This finding demonstrates that the free carbonium ion is the only important intermediate involved both in the exchange and in the solvolysis process. The isomerization is but slightly affected by the concentration of the common ion and appears to occur largely at a less advanced ionization stage, probably an intimate ion pair. (auth)

45294 SOLVOLYSIS OF PRIMARY ALKYL TOLUENESULFONATES IN CONCENTRATED SULFURIC ACID. EVIDENCE OF HYDROGEN PARTICIPATION. Myhre, Philip C.; Brown, Kenneth S. (Harvey Mudd Coll., Claremont, Calif.). J. Amer. Chem. Soc., 91: 5639-41(Sept. 24, 1969).

A study of the alkyl p-toluenesulfonate solvolysis in 96% H_2SO_4 shows the pattern of solvolysis rates (10^5k, sec^{-1} at 30°C) to be methyl (0.06), ethyl (1.55), propyl (32.1), isobutyl (450), and neopentyl (>3000). Solvolysis of CH_3CD_2OTs in 96% H_2SO_4 at 30°C proceeds with <5% rearrangement after nine half-lives (NMR). The α-d (1.18 ± 0.02) and β-d (1.20 ± 0.03) isotope effects are larger than normal, but they are significantly less than isotope effects associated with limiting solvolysis. (D.H.M.)

45295 SOLVOLYSIS OF ETHYL TOSYLATE IN HSO_3F. Myhre, Philip C.; Evans, Elizabeth (Harvey Mudd Coll., Claremont, Calif.). J. Amer. Chem. Soc., 91: 5641-4(Sept. 24, 1969).

A study was made of the products and isotope effects of HSO_3F solvolysis of ethyl tosylate that identifies conditions that results in rearrangement during the solvolysis. The kinetic isotope effects necessarily imply that appreciable force-constant changes involving both α and β hydrogen occur in the rate-limiting step of this solvolysis. (D.H.M.)

45296 FUNDAMENTAL ASPECTS OF PLUTONIUM CHEMISTRY. II. STUDIES ON OXIDATION OF THE ELEMENT. Perez-Bustamante, J. A. (Junta de Energia Nuclear, Madrid). Energ. Nucl. (Madrid), 13: 23-45(Jan.-Feb. 1969). (In Spanish).

Pu(III), Pu(IV), Pu(V), Pu(VI) coexist in solution. This is due to the small differences of redox potentials of different oxidation states in interconversion and the tendency towards disproportionation. Analytical and technical difficulties in obtaining any oxidation state in pure form are increased by the radioactivity of Pu, which as a strong α-emitter exhibits radiolytic autoreduction, and by the tendency of Pu(IV) and Pu(VI) to form colloidal solutions on hydrolysis. Thereby Pu atoms, linked by –O– or –H– bonds, may agglomerate to micelles containing up to 10^{10} Pu atoms. The survey covers also the unusual properties of metallic Pu and its recovery in pure form from irradiated U, Pu(II) which exists only in solid condition, and the recently discovered Pu(VII). Each oxidation state is discussed separately with emphasis on chemical and electrochemical methods of converting one into the other. Also organic chelating agents for Pu are considered. A diagram shows schematically the interconversion methods discussed. (F.J.W.)

45297 STUDY OF TUNNELING ROTATION OF METHYL GROUPS BY ELECTRON SPIN RESONANCE AND ELECTRON NUCLEAR DOUBLE RESONANCE. Clough, S.; Poldy, F. (Univ. of Nottingham, Eng.). J. Chem. Phys., 51: 2076-84(Sept. 1, 1969).

Free radicals formed by γ irradiation of single crystals of 4-methyl-2,6-di-tert-butylphenol were studied by resonance methods at low temperatures. The important part of the radical is the fragment $\dot{C}-CH_3$, where the free-electron spin occupies a 2p orbital centered on the carbon atom attached to the methyl group and experiences a hyperfine interaction with each of the three protons dependent on the proton position, giving rise to structure in the electron spin resonance spectrum which is sensitive to motion of the protons. The hindered methyl group performs torsional oscillations and also undergoes tunneling rotation between its three equivalent orientations, the nuclear spin states being correlated with the motion through the exclusion principle, at least at temperatures sufficiently low for the fragment to be regarded as isolated. An almost symmetrical seven line ESR spectrum was expected and was observed at 4.2°K. In first order the spectrum is independent of the tunneling frequency when this is large compared with the splitting due to the hyperfine interaction. The tunneling frequency was obtained from small relative shifts of the hyperfine lines measured by electron nuclear double resonance. From the hyperfine interaction tensors, the orientations of the methyl group symmetry axes were found. Above helium temperatures the ESR spectrum undergoes a change which was interpreted in terms of the onset of methyl-group rotations which are uncorrelated with the proton spin states and occur randomly. From this model, spectra were calculated as a function of the correlation time for the random motion. They show a progressive change from seven lines to the 1:3:3:1 quartet observed at high temperatures. The details of the observed transition are in good agreement. (auth)

45298 EFFECT OF H_2 AND D_2 ON THE VIBRATIONAL NAPIER (RELAXATION) TIME OF N_2O AT TWO TEMPERATURES (32° AND 52°C). Mueller, Richard Anton. Washington, D. C., Catholic Univ. of America, 1968. 59p.

Thesis.

The absorption of ultrasound in N_2O with varying small amounts of H_2 and D_2 was measured with a Hubbard-type, variable path, recording acoustic interferometer at 32 and 52°C. The usual single-relaxation-time theoretical absorption curve could be fitted to the data within experimental error. Variation of the frequency of maximum absorption with impurity content was found to be linear as expected. N_2O-H_2 collisions were determined to be twice as effective as N_2O-D_2 collisions in equilibrating vibrational energy in N_2O at the two temperatures. At the lower temperature, N_2O-H_2 and N_2O-D_2 collisions were found to be 1.3 times more effective than at the higher temperature, while N_2O-N_2O collisions were found to be 1.17 times more effective at the higher temperature. Thus, for these substances and temperatures, the variation in collision efficiency with temperature in heterogeneous collisions is the reverse of the corresponding effect in homogeneous ones. (Diss. Abstr.)

45299 HEATS OF VAPORIZATION OF UO_2 AND UO FROM UO_2. Sakaki, Noriaki; Kubo, Kenji; Asano, Mitsuru; Magari, Saburo (Kyoto Univ.). J. Nucl. Sci. Technol. (Tokyo), 6: 478-80(Aug. 1969).

The heats of vaporization of UO_2 and UO were measured from

UO_2 deposited on W and Re filaments using experimental data on the ionic emission of UO_2^+ and UO^+ caused by surface ionization as well as on thermoelectronic emission. From the results it was surmised that the differences in the measured values of the surface work function, ϕ, for UO_2–W and UO_2–Re, i.e., the differences in the heat of vaporization for the ionic species for UO_2^+, would be due to adsorption of the dissociated U on the base surface in the higher temperature range. Data are tabulated. (P.C.H.)

45300 NORMAL AND INVERSE VAPOR PRESSURE ISOTOPE EFFECTS ON AMMONIA. Wolff, H.; Hoepfner, A. (Univ., Heidelberg). Ber. Bunsenges. Phys. Chem., 73: 480-3(Aug. 1969). (In German).

The measurements of vapor pressure ratios of undiluted ammonia and trideuterated ammonia were completed and the partial pressure ratios at large dilution with propane determined from isothermal vapor pressure measurements. The average value of the ratios p^D/p^H measured over the temperature range −25 to −55°C was 1.043. The vapor pressure isotope effect of ammonia as well as the effects of other substances that form hydrogen bonds, therefore, were inverse at the state of monomers. (auth)

45301 FIRST EXCITED $^1\Sigma_g^+$ STATE OF THE HYDROGEN MOLECULE AND ITS ISOTOPES. Boye, Robert James. Baltimore, Johns Hopkins Univ., 1968.

Thesis.

A detailed theoretical analysis of the first excited $^1\Sigma_g^+$ state of the H molecule and its isotopes is presented. A linear variational method based on a James and Coolidge wave function was used to compute a potential curve for the electronic motion. The potential curve obtained has two minima. A 24-term wave function gave a potential minimum at R = 1.9 atomic units (au) of −0.71749 au as compared to the experimental value of −0.7181 au. A minimum energy of −0.70532 au was obtained at R = 4.3 au as compared to Davidson's calculated value of −0.70067 au at R = 4.35 au obtained using the linear variational method with a wave function of 18 terms containing a linear combination of configurations. Using this potential curve, vibrational and rotational levels were then computed by a numerical method for the H molecule and its isotopic species. The results for H_2, D_2, and T_2 are compared with experimental values. The levels below the potential barrier separating the two minima were classified as belonging to the separate minima by examining the rotational differences and the wave functions for the nuclear motion. Above the barrier the probability density was approximately the same for both minima. The lowest term levels determined for the minimum at the larger internuclear separation have not been verified experimentally. Applications to other states using the same method are considered. The potential curve for the second excited $^1\Sigma_g^+$ state also has a double minimum. Results were obtained in the vicinity of the minimum at the larger internuclear separation. A minimum energy of −0.6564 au was obtained at R = 3.4 au as compared to Davidson's calculated value of −0.6506 au at R = 3.5 au. (Diss. Abstr.)

Radiation and Nuclear Chemistry

Refer also to abstracts 45227 and 45650.

45302 (BARC–384) SOME STUDIES ON THE RADIATION CHEMISTRY OF TRIDODECYL AMINE. Bhattacharyya, P. K.; Veeraraghavan, R. (Bhabha Atomic Research Centre, Bombay (India)). 1968. 28p. Dep. CFSTI (U. S. Sales Only).

Some studies on the radiation chemistry of tridodecylamine (TDA) by ^{60}Co gamma radiolysis are described. It was found that the product hydrogen gas formed with $G(H_2)$ 5.8, which decreased with dose. The decrease is explained on the basis of reaction of molecular hydrogen with excited species. The G(–TDA) was qualitatively estimated to be in the range from 2 to 3.8. The evidence of formation of RNHCOR when TDA was irradiated in the presence of air was obtained by infrared studies. Using the results of the present investigations a mechanism of TDA radiolysis is proposed. (auth)

45303 (CNM-R-2(Vol.1), pp 357-60) PRODUCTION OF HIGH SPECIFIC ACTIVITY ISOTOPES BY THE IRRADIATION OF METAL ACETYLACETONATES. McLain, Milton E. Jr. (Georgia Inst. of Tech., Atlanta).

Cobalt and chromium complexes with 2,4-pentanedione were irradiated at times from 30 sec to 60 hr. The samples were then dissolved in benzene and extracted with nitric acid. At least 95% of the ^{60}Co and ^{51}Cr activity was extracted into the dilute nitric acid phase. This efficient separation of the radioisotopes was accompanied by less than 1% of the nonactivated element. (M.C.G.)

45304 (CNM-R-2(Vol.1), pp 375-89) OPTIMIZATION OF THE REACTOR IRRADIATION SCHEDULE FOR THE PRODUCTION OF RADIOISOTOPES AS A FUNCTION OF THE DEMAND. Morales Amado, A.; Martinez, A. M.; Trevino A., R. (Comision Nacional de Energia Nuclear, Mexico City. Centro Nuclear de Mexico).

The production of three groups of radioisotopes was studied as a function of the demand and the production possibilities for different irradiation schedules. The specific activities obtained were compared with postulated demands, to establish an optimization criterion for the schedules. Two criteria were followed. The first one compares the available irradiation volume in the reactor with the theoretically calculated volume that satisfies the different demands, and the second one compares the volume needed, if the specific activity available from other laboratories to satisfy the different demands is used, with theoretically calculated volume. (auth)

45305 (COO–38-621(Rev.)) THESAURUS FOR RADIATION CHEMISTRY. (Notre Dame Univ., Ind. Radiation Lab.). May 1968; Revised Aug. 1969. 55p. Dep. CFSTI.

A list of keywords, developed for indexing papers in radiation chemistry, is presented. The keyword list is followed by a formula list; a few species are indexed by their formulas instead of a name. (M.C.G.)

45306 (IRI–133-69-6) GRAFT COPOLYMERS OF PAPER CELLULOSE PRODUCED BY IONIZING RADIATION. Cramer, W. A.; Houtman, J. P. W.; Ninck Blok, C. J. J.; Hogervorst, D. (Reactor Instituut Delft (Netherlands)). [1969]. 16p. (CONF-690805–5). Dep. CFSTI (U. S. Sales Only).

From Symposium on Utilization of Large Radiation Sources and Accelerators in Industrial Processing, Munich, Germany.

Studies were made on the radioinduced graft polymerization of sheets of paper with various monomers, such as methyl methacrylate, acrylamide, methyl acrylate, acrylonitrile, and butyl acrylate, using γ rays at dose rates of about 0.1 and 10 Mrad/hr and with 1-MeV electrons at a dose rate of about 360 Mrad/hr. Graft polymers were produced by irradiation, either before adding monomers or in the presence of monomers. Wet and dry tensile strengths of the products were compared with those of untreated samples. It was concluded that a considerable increase in dry and wet strength can be obtained by radioinduced graft polymerization of sheets of paper. (P.C.H.)

45307 (RD/B/M–1297) A REVIEW OF THE REACTION OF CARBON WITH WATER VAPOUR AND HYDROGEN. Swan, T. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Aug. 1969. 31p. Dep. CFSTI (U. S. Sales Only).

Studies of the thermal reactions occurring between carbon and water vapor and carbon and hydrogen are reviewed up to 1968. Information from a variety of sources was collected in an attempt to predict the effect of γ radiation on these processes and the limited experimental investigations of this effect are described. (auth) (UK)

45308 (UCLA–12-749) PULSE RADIOLYSIS OF NUCLEIC ACID CONSTITUENTS AND RELATED COMPOUNDS. I. OPTICAL SPECTRUM AND REACTIVITY OF THE 5,6-DIHYDROTHYMINYL FREE RADICAL. Myers, L. S. Jr. (California Univ., Los Angeles. Lab. of Nuclear Medicine and Radiation Biology); Theard, L. M. (Gulf General Atomic, Inc., San Diego, Calif.). [1969]. Contract AT(04-1)-Gen-12. 16p. Dep. CFSTI.

Dilute aqueous solutions of dihydrothymine, saturated with N_2O, were irradiated at pH 6.8 and 1.0 with sub-microsecond pulses of 10-MeV electrons, and changes in optical absorbance were observed for periods up to 800 μsec in the wavelength range 300 to 600 nm. A broad absorption band with a maximum at 400 nm was assigned to the 5,6-dihydrothymin-5-yl free radical. This absorption was also observed in reactions of H· with thymine, but not in reactions of e_{aq}^- with thymine and subsequent protonation of the anion radical. The dihydrothymin-5-yl radical was stable with respect to intramolecular reactions, and decayed by second order kinetics with $2k = 2.35 \times 10^9$ M^{-1} sec^{-1} at pH 6.8 and 1.3×10^9 at pH 1.0. The slower decay in acid solutions is consistent with partial protonation of the radical. (auth)

45309 (UCRL–50698) EVIDENCE FOR THE FORMATION AND MOTION OF MOLECULAR HYDROGEN IN IRRADIATED LITHIUM HYDRIDE. Leider, Herman R. (California Univ., Livermore. Lawrence Radiation Lab.). July 2, 1969. 8p. Dep. CFSTI.

It was reported in a previous study that the motionally narrowed hydrogen seen with pulsed nuclear magnetic resonance in irradiated Li(^1H, ^3H) does not have the same isotopic composition as the original lithium hydride. This experiment was repeated with a different isotopic composition to extend the range of the data. The hydrogen

that gives rise to the motionally narrowed NMR signal was shown to be in high density gas bubbles that must form by diffusion processes. It is proposed that the difference in isotopic composition is due to the mass dependence in the diffusion coefficient, and arguments are given to support the idea that the diffusing species is molecular hydrogen. (auth)

45310 RADIOISOTOPE PROCESSING. Ruiz, Carl P.; Rider, Benjamin F.; Gerhart, James M. (to General Electric Co.). U. S. Patent 3,459,634. Filed Sept. 19, 1966.

A method of preparing and separating ^{227}Ac and ^{228}Th from ^{226}Ra is described. Radium-226 is irradiated with neutrons for a period sufficient to form a mixture of ^{227}Ac, ^{228}Th, and ^{226}Ra. The mixture is dissolved in an aqueous acid solution; the ^{228}Th is extracted with an organic solvent; the pH of the aqueous solution is adjusted; and the ^{227}Ac is extracted. The resulting organic solution is dried, and the dried material containing the ^{227}Ac is dissolved in aqueous acid solution. The ^{227}Ac is adsorbed onto a column containing D2EHPA or one of its homologs, and then the purified ^{227}Ac is eluted from the column. (Offic. Gaz.)

45311 ION-MOLECULE REACTIONS. Boris Levy (to Mobil Oil Corp.). U. S. Patent 3,462,354. Filed June 16, 1964.

A method is described for carrying out an ion-molecule reaction in a gaseous system by irradiation of a mixture comprising a molecule reactant, an ion reactant precursor, and a rare gas. The molecular reactant has an ionization potential greater than that of the ion reactant precursor; the rare gas has an ionization potential intermediate to those of molecule reactant and the precursor and above that of the precursor. The rare gas is present in a major amount, and the molecule reactant is present in an amount greater than that of the precursor. (Offic. Gaz.)

45312 RADIATION-INDUCED EMULSION POLYMERIZATION OF VINYL ACETATE AND STYRENE. Stannett, V.; Gervasi, J. A.; Kearney, J. J.; Araki, K. (Research Triangle Inst., Research Triangle Park, N. C.). J. Appl. Polym. Sci., 13: 1175-89(June 1969).

Studies have been made on the γ-induced emulsion polymerization of styrene and comparisons made with chemically initiated emulsion polymerization. The polymerization proceeded smoothly to high conversions at 0 and 60°C, the reaction showing a high G (monomer) value. Complete conversions were obtained with total doses of less than 0.05 Mrad. In accordance with the behavior expected of systems having a constant rate of initiation, the molecular weight was found to decrease with decreasing temperature The molecular weight and particle size distributions were narrower than those obtained in chemically initiated emulsion polymerizations at the same temperature. The radioinduced emulsion polymerization of vinyl acetate proceeded smoothly at temperatures in the range 0 to 50°C to give polymers of much higher molecular weight than these obtained from chemically initiated polymerizations at the same temperature. Complete conversion was attained after a dose of 0.02 Mrad for latices approaching 50% solids. The elimination of ionic endgroups in the poly(vinyl acetate) radicals tends to drive the polymerization from the aqueous phase, resulting in faster rates and higher molecular weights than are obtained from chemically initiated systems. Rates of polymerization were found to be independent of temperature and the molecular weight of the polymer to be independent of dose rate. Latices of poly(vinyl acetate) of high solids content were evaluated for latex and film properties and found to have improvements over commercially available samples in both areas, especially in clarity of film and scrub resistance. A number of acrylate and maleate esters were copolymerized with vinyl acetate in a radiation initiated emulsion system. High molecular weight copolymers were produced after low dose. (auth)

45313 THE INFLUENCE OF CHEMICAL COMPOSITION ON THE ANNEALING REACTIONS OF RADIOIODINE RECOILS FORMED BY HIGH-ENERGY PROTON IRRADIATION OF SOLID CESIUM SALTS. Dema, I. (Inst. of Atomic Physics, Bucharest); Zaitseva, Natalia G. Rev. Roum. Phys., 14: 367-75(1969).

The effects of chemical composition and purity on the yields of radioiodine in oxy-forms was studied in some solid cesium compounds. In cesium chloride irradiated by high energy protons the percentage of oxidized radioiodine depends on the source of material. In solid cesium nitrate, sulfate, carbonate, chromate, and citrate the anion of the target has a marked influence of the radioiodine distribution between its higher and lower valency states. Thermal annealing and light bleaching of these salts were also investigated. (auth)

45314 RADIOLYSIS OF THE DIMERS OF DIMETHYLTHYMINE IN THE CRYSTALLINE STATE. Weinblum, D. (Univ., Toronto. Ontario Cancer Inst., Toronto). Radiat. Res., 39: 731-44(Sept. 1969).

Four isomeric photodimers of dimethylthymine (I syn, head to head, II anti, head to head, III syn, head to tail, IV anti, head to tail), have been irradiated in the crystalline state with ^{60}Co γ rays. The exclusive radiolysis product of all four dimers was dimethylthymine. The initial G-value for this reaction was 6300, 1700, 14, and 19 for dimers I, II, III, and IV, respectively. For all four compounds, the G-values decreased with increasing conversion of the dimer to dimethylthymine. For I and II the initial G-values were lower for smaller and less perfect crystals. In aqueous solution the radiolysis proceeded by a different mechanism and dimethylthymine was only a minor reaction product. In this case, the G-values for destruction of I, II, III, and IV were 1.2, 1.5, 1.2, and 1.2, respectively. For the radiolysis in the crystalline state, the possibility of a chain reaction mechanism is discussed. (auth)

45315 IN-PILE IRRADIATION OF SOME THALLIUM COMPOUNDS. Frediani, S.; Lo Moro, A. (CAMEN, Pisa, Italy). Energ. Nucl. (Milan), 16: 520-2(Aug. 1969). (In Italian).

The feasibility of production of high specific activity ^{204}Tl was studied. Solid perchlorate and thallous nitrate, both solid and in solution, were neutron- and γ-irradiated in a nuclear reactor. A decomposition reaction of the perchlorate salt in solid phase with formation of Tl_2O_3 was revealed. This reaction is quantitative for large radiation doses. Reduction of Tl(I) to metallic Tl, as a grey spongeous precipitate, was also detected after irradiation of Tl(I) in solution in presence of KCN. (auth)

45316 RADIO-INDUCED PRODUCTION OF DIBUTYLTIN DIBROMIDE AT HIGH TEMPERATURES. Hallman, Donald Fhay. Raleigh, N. C., North Carolina State Univ., 1968. 167p. Thesis.

Studies were carried out to determine the γ radioinduced reaction between Sn and 1-bromobutane at 220°C in a Pyrex vessel. The 1-bromobutane was kept in the liquid phase at high temperatures by an overpressure of inert gas. The effects of temperature, pressure, dose, dose rate, and 1-bromobutane concentration were studied. The reaction showed no pressure dependence; yields increased with temperature to 160°C, and decreased rapidly above 160°C. Dose rate data indicate that the reaction for production of dibutyltin dibromide has a trimolecular termination step. Based on the experimental data, an industrial plant was designed for the production of dibutyltin dibromide. The manufacturing costs for this plant were $1.707/lb of dibutyltin dibromide, FOB plant. The cost contribution of the radiation source and radiation-related equipment were $0.011/lb. (Disser. Abstr.)

45317 PROCESS FOR PRODUCING GRAFT COPOLYMERS USING RADIATION. Restaino, Alfred J.; Reed, Weldon N. (to Atlas Chemical Industries, Inc.). U. S. Patent 3,461,052. Filed Jan 3, 1967.

A process is described for radioinduced grafting of vinyl monomers to hydrophilic polymeric substrates, particularly poly(vinyl alcohol), by contacting the substrate moistened with water with the fluid vinyl monomer capable of free radical-catalyzed polymerization and irradiating it with high-energy ionizing radiation to a dosage of 2000 to 10^6R. (Offic. Gaz.)

45318 ELECTRON SPIN RESONANCE SPECTRUM OF GAMMA IRRADIATED POLYSTYRENE. Verma, G. S. P.; Peterlin, A. (Camille Dreyfus Lab., Durham, N. C.). J. Polym. Sci., Part B, 7: 587-90(Aug. 1969).

The observations of different splittings due to two sets of β-methylene protons in the ESR spectra of the free radical $\sim\sim CH_2-\underset{\alpha}{C}-\underset{\beta}{CH_2}\sim\sim$ in γ-irradiated polystyrene are reported. The spectrum assigned to the radical is illustrated. (P.C.H.)

45319 MOLECULAR WEIGHT DISTRIBUTION IN RADIATION-INDUCED POLYMERIZATION. I. γ-RADIATION-INDUCED FREE-RADICAL POLYMERIZATION OF LIQUID STYRENE. Huang, R. Y. M.; Westlake, J. F.; Sharma, S. C. (Univ. of Waterloo, Can.). J. Polym. Sci., Part A-1, 7: 1729-47(July 1969).

The kinetics of γ-radioinduced free-radical polymerization of styrene were studied over the temperature range 0 to 50°C at radiation intensities of 9.5×10^4, 3.1×10^5, 4.0×10^5, and 1.0×10^6 rad/hr. The overall rate of polymerization was found to be proportional to the 0.44 to 0.49 power of radiation intensity, and the overall activation energy for the radioinduced free-radical polymerization of styrene was 6.0 to 6.3 kcal/mole. Values of the kinetic constants, k_p^2/k_t and k_{trm}/k_p, were calculated from the overall polymerization rates and the number-average molecular weights. Gel-permeation chromatography was used to determine the number-average molecular weight $\bar{M}_n$, the weight-average molecular weight $\bar{M}_w$ and the polydispersity ratio $\bar{M}_w/\bar{M}_n$, of the product polystyrene. The polydispersity ratios of the radiation polymerized polystyrene were found to lie between 1.80 and 2.00.

Significant differences were observed in the polydispersity ratios of chemically initiated and radioinduced polystyrenes. The radiation chemical yield, G(styrene), was calculated to be 0.5 to 0.8. (auth)

45320 ESR STUDY OF RADICAL SITES IN CRYSTALLINE TEXTURE OF IRRADIATED POLYPROPYLENE BY MEANS OF NITRIC ACID ETCHING. Kusumoto, Naoshi; Matsumoto, Kazuki; Takayanagi, Motowo (Kyushu Univ., Fukuoka). J. Polym. Sci., Part A-1, 7: 1773-87(July 1969).

Bulk-crystallized isotactic polypropylene samples with different crystalline textures were etched by fuming nitric acid to remove the disordered region. The radicals produced by irradiation of γ rays or ultraviolet light on these etched samples in vacuum at liquid nitrogen temperature were investigated by the ESR method. A triplet spectrum in addition to the original spectrum of polypropylene radicals was separated for the etched samples. It was concluded that this triplet was caused by radical species associated with nitro groups introduced on the surface of the crystalline residues by etching. The difference in the intensity of this triplet among the samples was ascribed to differences in crystalline textures and interpreted in a quantitative way. The concentration of polypropylene radicals corrected for the triplet differed among the quenched, annealed, and cold-drawn samples and the sample annealed one after drawing. This fact was interpreted on the basis of the hypothesis that radical sites were almost concentrated in the defects of crystal domain. The well known nonet spectrum, which can be observed at liquid nitrogen temperature after annealing the irradiated samples at room temperature, was also confirmed to be attributable to the defects of crystals. The behavior of free methyl radicals induced by ultraviolet irradiation was also found to be strongly dependent on the state of aggregation of the polymer molecules. (auth)

45321 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF DERIVATIVES OF METHACRYLIC ACID. II. POST-IRRADIATION POLYMERIZATION OF OCTADECYL METHACRYLATE. Bowden, M. J.; O'Donnell, J. H. (Univ. of Queensland, Brisbane). J. Polym. Sci., Part A-1, 7: 1657-64(July 1969).

Octadecyl methacrylate (mpc ≈ 12°C) polymerized readily in the solid state in the temperature range −30 to +12°C after gamma irradiation at −196°C. The initial rate of polymerization and the "limiting" conversion increased with radiation dose and temperature. The temperature dependence of the rate corresponded to an "apparent" activation energy of 20 kcal/mole. Difficulties were experienced with polymerization during separation of the polymer from residual monomer, but these were minimized by using low radiation doses and a hot, selective solvent. The maximum conversion achieved was 70%. The polymer was crosslinked, even at low conversions. (auth)

45322 RADIATION-INDUCED SOLID-STATE POLYMERIZATION OF DERIVATIVES OF METHACRYLIC ACID. III. AN ELECTRON SPIN RESONANCE STUDY OF RADICAL REACTIONS IN IRRADIATED OCTADECYL METHACRYLATE. Bowden, M. J.; O'Donnell, J. H. (Univ. of Queensland, Brisbane). J. Polym. Sci., Part A-1, 7: 1665-74(July 1969).

The ESR spectrum of gamma-irradiated octadecyl methacrylate (mp ≈ 12°C) was due to a mixture of three radicals formed by (1) loss of a hydrogen atom from the paraffin chain, (2) addition of a hydrogen atom to the double bond, and (3) addition of a monomer molecule to radicals formed by (1) or (2). On warming monomer added to radicals (1) and (2) between −170 and −50°C, and above −50°C the spectrum was solely due to propagating methacrylate radicals. The total radical concentration decreased slightly at −150°C and was then constant up to −30°C. A marked decrease in radical concentration occurred from −30 to +12°C, it took place rapidly and reached an equilibrium value after each successive increase in temperature. Differential thermal analysis indicated a solid−solid phase change at −30°C. When the sample was kept at 0°C there was no further decrease in radical concentration even with 50% conversion to polymer. With 2% added chloranil the (chloranil)$^-$ was observed to be of about the same concentration as methacrylate radicals. The initial total radical concentration was lower and decreased to zero by 0°C on warming. No polymer was obtained. (auth)

45323 STUDY ON DISTRIBUTION OF MOLECULAR WEIGHT IN RADIATION INDUCED SOLID STATE POLYMERIZATION. 2. Ohnishi, Teruaki; Tabata, Yoneho (Tokyo Univ.). Kobunshi Kagaku, 26: 385-92(June 1969). (In Japanese).

Molecular weight distribution and average molecular weight of polymers obtained by radioinduced solid-state polymerization were calculated. In the calculation, effective monomer concentration was introduced, and the annealing of crystal monomers during polymerization was taken into consideration. In overall differential molecular weight distribution, two peaks appear in the distribution curve only when the chain transfer coefficient and the monomolecular termination coefficient are in a limited range. The shape of lower peak is much influenced by the nucleation phenomenon. The average molecular weight was calculated on the basis of these molecular weight distribution functions, as a function of polymerization period for both post and in-source polymerizations. Although the results of the calculation agree well with the reported experimental results qualitatively, it is difficult to discuss it quantitatively, since the average molecular weight is less influenced by the various parameters. (NSA of Japan)

45324 RECENT ASPECTS OF THE USE OF IONIZING RADIATIONS IN POLYMERIZATION PROCESSES. Mele, A. (Univ., Rome). Com. Naz. Energ. Nucl., Notiz., 15: No. 6, 106-10(June 1969). (In Italian).

Recent developments in the use of ionizing radiations in polymerization processes are discussed. (44 references). (P.C.H.)

45325 ELECTRON SPIN RESONANCE OF X-IRRADIATED SINGLE CRYSTALS OF DL-TARTARIC ACID AT 77°K. Moulton, Grace C.; Cernansky, M. Pierre (Florida State Univ., Tallahassee). J. Chem. Phys., 51: 2283-4(Sept. 1, 1969).

Ionic radicals produced in monocrystalline, deuterated DL-tartaric acid, COODCHODCHODCOOD·D_2O, x-irradiated at 77°K, were observed. ESR studies indicated the primary radical to be a doublet that is almost isotropic with a g value that is also almost isotropic. A possible structure is given. (J.G.B.)

45326 INDUSTRIAL CHEMICAL REACTORS IN OPERATION. Turkm. Iskra, No. 233: 2(Oct. 4, 1968).

A prototype of a radiation-chemical reactor for obtaining sulfonyl chlorides was constructed, tested, and is now operating at the Volgograd Chemical Combine. The reactor produces synthetic detergents and surface-active substances and enough synthine to cover about a third of the country's needs. The source of the γ radiation is ^{60}Co; its activity is equivalent to 2.5 kg of Ra. The source is surrounded by almost a half-meter of cast iron, which serves as the biological shielding. (JPRS)

45327 EFFECT OF GAMMA RAY IRRADIATION ON STABILITY OF FeEDDHA SOLUTION AT TWO pH LEVELS. Romney, E. M., Wallace, A.; Wieland, P. A. T.; Leo, M. W. M.; Wallace, G. A. (Univ. of California, Los Angeles). Contract (AT 11-1)-34. Agron. J., 61: 652-3(July-Aug. 1969). (UCLA-34-P-51-25).

Irradiation of FeEDDHA solutions with gamma rays from a ^{60}Co source resulted in the same type of degradation of the iron chelate that sunlight causes. Effects of both types of radiation were more pronounced at low pH than at high pH. Hydrogen peroxide seemed to have a similar effect. (auth)

45328 PREPARATION OF ^{82}Br-LABELED BROMOPHOS BY NEUTRON ACTIVATION. Grzymala, Wieslaw; Syrowatka, Tadeusz; Palut, Danuta (Inst. of Hygiene, Warsaw). Rocz. Panstw. Zakl. Hig., 19: 587-91(1968). (In Polish).

Preparation of Bromophos (2,4-dichloro-5-bromophenyl-O,O-dimethylthionphosphate) labeled with ^{82}Br was attempted by irradiation of the nonactive compound with a neutron flux of 10^{12} n/cm^2 sec for 1, 3, 6, 24, and 48 hr. The radioactivities attained at these 5 time periods based on 20 mg Br were for ^{82}Br and ^{80}Br, respectively: 25, 178 μCi; 53, 350; 158, 780; 540, 1300; and 900, 1400. Formation of ^{32}P and ^{35}S was also observed. Chromatographic patterns of the organic molecules present in the irradiated substance are shown. Progressive disappearance of the original compound and formation for 3 or 4 degraded fractions were noted. The yield of Bromophos-^{82}Br amounted to 16.8 and 19.0% after 6 and 24 hr neutron irradiation. These quantities of the labeled compound, after purification by thin-layer chromatography, were considered to be sufficient for investigation of the metabolism of Bromophos in plants and animals. (BBB)

45329 PRODUCTION OF ^{85}Sr ON CYCLOTRON. Krasnov, N. N.; Dmitriev, P. P.; Erlychenko, V. P.; Konstantinov, I. O.; Konyakhin, N. A.; Sevast'yanov, Yu. G.; Tuev, V. M.; Gruby, I.; Knoblokh, B.; Mudrova, B. At. Energ. (USSR), 27: 13-16(July 1969). (In Russian).

Different methods of ^{85}Sr production ($T_{\frac{1}{2}}$ = 64 d) on the cyclotron are considered. Yield curves of ^{85}Sr vs energy for the proton and deuteron bombardment of rubidium metal are given. The targets for rubidium chloride and metal as well as the isolation methods of ^{85}Sr from these targets are described. (auth)

45330 RADIATION CROSSLINKING STUDIES ON BRANCHED POLYVINYL ACETATE. Mittelhauser, H. M. Jr.; Graessley, W. W. Polymer, 10: 439-45(June 1969).

Crosslinking and chain scission caused by gamma radiation in branched poly(vinyl acetate) have been studied. Gel fraction was measured as a function of radiation dose in five well-characterized

samples, ranging in structure from almost linear to approximately 1.7 branch points per molecule. Apparent G-values (events per 100 eV of energy absorbed) from random scission and crosslinking, G(S) and G(X) respectively, were obtained from the solubility behavior at high doses, and G(X) was separately evaluated at low doses from gel point measurements. For each sample the values of G(X) were similar at high and low doses, but they decreased from sample to sample as the branching density increased. All observations were consistent with the supposition that approximately 15 percent of the branch points are sensitive to radiation and break preferentially prior to the gel point. Several types of branches are known to exist in poly(vinyl acetate), which may account for the apparent differences in radiation sensitivity among branches. (auth) (UK)

45331 PREPARATION OF ^{147}Pm METAL AND DETERMINATION OF THE DENSITY AND MELTING POINT. Wheelwright, E. J. (Battelle Memorial Inst., Richland, Wash.). J. Phys. Chem., 73: 2867-71(Sept. 1969).

Four 30-g buttons of ^{147}Pm metal were prepared by Ca reduction of anhydrous $PmCl_3$. Additional purification was obtained by vacuum distillation of Ca and Mg impurities. The density of the metal was found to be 7.22 ± 0.03 g/cm^3, and the melting point is 1168 ± 6°C. (auth)

45332 ANALYSIS OF THE RECOIL PRODUCTS IN NEUTRON IRRADIATED PHENYLARSENIC COMPOUNDS. PART III. DETERMINATION OF THE YIELD OF DIPHENYLARSINE RECOIL PRODUCTS. Grossmann, G. (Technische Univ., Dresden). Isotopenpraxis, 5: 203-4(May 1969). (In German).

Neutron-irradiated samples of diphenylarsinic acid (hydroxydiphenylarsine oxide) and triphenylarsine were studied. Data from electrophoretic chromatograms are presented in graphs. (M.C.G.)

45333 ^{90}Y- AND ^{140}La-GENERATORS. Mikheev, N. B. Isotopenpraxis, 5: 188-9(May 1969). (In Russian).

A technique for manufacturing ^{90}Y and ^{140}La generators is proposed based on the use of aluminum oxide as the sorbent. The radionuclide is eluted from the generator by tributyl phosphate saturated with nitric acid. The yield is higher than 90% and isotopic purity better than 99.9%. If required the radioisotopes may simply be transferred from the tributyl phosphate solution into an aqueous one. (auth)

45334 INFRARED STUDY OF THE RADIOLYSIS OF CARBON DIOXIDE, AMMONIA, AND HYDROGEN ADSORBED ON SILICA. Abrams, Lloyd; Sutherland, James W. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Chem., 73: 3160-2(Sept. 1969).

The γ radiolysis of ammonia, carbon dioxide, and hydrogen absorbed on silica was studied in an effort to determine whether the identity of an intermediate surface species could be established by infrared techniques. It was concluded that more thorough investigative techniques are needed in order to determine the specific surface reactions involved. Residual hydroxy groups on silica surfaces seem to play an important role in heterogeneous radiolytic processes. (D.H.M.)

45335 EFFECT OF POLAR MOLECULES ON REACTION OF NEGATIVE IONS IN RADIOLYSIS OF HYDROCARBON + NITROUS OXIDE SYSTEMS IN THE GAS PHASE. Redpath, J. L.; Simic, M. (Univ. of Newcastle Upon-Tyne, Eng. Army Natick Labs., Natick, Mass.). J. Phys. Chem., 73: 2809-14(Sept. 1969).

In the radiolysis of gaseous hydrocarbons containing small amounts of N_2O (2 mol %) the radiation-produced electrons react with N_2O leading eventually to $G(N_2) > G_e$. In the presence of polar molecules with low electron affinity (H_2O, NH_3, CH_3Cl) a limiting value of $G(N_2) = G_e$ could be reached depending on the concentration of the polar compound and the temperature of the system. It is suggested that the clustering of O^- (or N_2O^-) in addition to proton transfer inhibits the formation of the excess nitrogen yield ($\Delta G(N_2) = G(N_2) - G_e$). At temperatures above 80° $G(N_2) = 2G_e$. (auth)

45336 IRRADIATED ARTICLE. Cook, Paul Maxwell (to Raychem Corp.). British Patent 1,161,259. Aug. 13, 1969. Priority date Oct. 31, 1966, United States.

A process is described for producing a heat-recoverable article comprising a polymeric material differentially crosslinked by irradiation. The article has two opposite surfaces with the material in one surface being made up of crosslinked infusible material and the other surface being made up of fusible, substantially noncrosslinked material. At least a part of the material between the two surfaces is crosslinked, and the degree of crosslinking decreases with the distance from the surface comprised of the crosslinked material. The fusible substantially noncrosslinked material is capable of fusing at the recovery temperature of the article. Preferably, the article is tubing with the outer surface being the region of crosslinked infusible material. The polymeric material used is one capable of having the property of elastic memory imparted to it, and typical materials are crosslinked polyolefins, crosslinked polyvinyl halides, crosslinked polyvinylidene halides, crosslinked ethylene-vinyl acetate copolymers, crosslinked ethylene-ethyl acrylate copolymers, and crosslinked polyamides. (B.L.M.)

45337 THE ACTION OF IONIZING RADIATIONS ON THE CHELATION REACTION OF METALLIC IONS BY DNA MACROMOLECULES. Furnica, G. (Institutul de Igiena, Bucharest). Rev. Roum. Biochim., 6: 17-27(1969). (In French).

The ability of DNA to form chelate complexes with various metallic ions was demonstrated using ^{58}Co, ^{59}Fe, ^{65}Zn, ^{88}Y, ^{110}Ag, and ^{134}Cs. The effect of ^{60}Co γ irradiation of DNA solutions on its affinity for these ions was tested. The doses used varied from 1.5×10^{15} to 6.5×10^{20} eV/5 ml of a 0.01% DNA solution. The DNA was then dialyzed against solutions of the cations. After irradiation the amounts of Ag^+ and Zn^{2+} that were bound by DNA were increased and the amount of Cs^+ was decreased compared with native DNA. A slight increase of Y^{3+} and slight decrease of Co^{2+} were noted. The effects of irradiation of DNA on its structure are discussed, as well as the site of binding of the cations. The bases, deoxyribose, and phosphate groups are all involved in the binding. A schematic diagram for the binding is shown. (BBB)

45338 FORMATION AND RECOMBINATION OF H_3O^+ AND HYDROXIDE IN IRRADIATED WATER. Schmidt, Klaus H.; Ander, Sabine M. (Argonne National Lab., Ill.). J. Phys. Chem., 73: 2846-52(Sept. 1969).

Measurements of transient conductivity changes in aqueous solutions during and after irradiation with 15-MeV electron pulses were carried out to study the formation and recombination of hydrogen and hydroxide ions. The hydrogen ion yield is $G_{H^+} = 2.9 \pm 0.2$ (ions/100 eV), independent of the pulse dose and the pH between 5 and 9. On the basis of $G_{e^-} = 2.8$, $G_{OH^-} = 0.1$. The apparent neutralization rate constant $k_{(H^+ + OH)}$ varies between 4.4×10^{10} and 1.5×10^{11} M^{-1} sec^{-1}, depending on pulse dose and pH; H^+ is synonymous with H_3O^+. Lower rate constants were obtained by increasing the number of ions formed by radiation and also by decreasing the concentrations of ions present before irradiation. The experimental data are consistent with the hypothesis that H^+ and OH^- ions produced by radiation recombine more slowly than normal ions at equilibrium, possibly due to a different structure of their hydration shells. However, their mobilities must be the same as those of normal ions, according to experimental evidence. It was further found that N_2O, but not H_2O, converts hydrated electrons into hydroxide ions within less than 0.2 μ sec. With H_2O_2, a negatively charged intermediate forms that has a half-life of 0.3 sec in alkaline solution. (auth)

45339 ON THE FLUORESCENCE CHANGE IN TERPHENYL IRRADIATED IN A NUCLEAR REACTOR. Kawakubo, Tetsuya; Okada, Moritami; Shibata, Toshikazu. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 269-73(Oct. 1968).

Compressed flakes of polycrystalline terphenyl were irradiated in a reactor, and their fluorescence changes were measured. Irradiation for six minutes at a reactor power of 1.0 MW reduced the fluorescence intensity to 44%. This decrement is explained by the exciton theory of Birks. (Birks, J. B. and F. A. Blach, Proc. Phys. Soc. A 64: 551(1961)) Radiation effects on the fluorescence of terphenyl dissolved after the irradiation were also measured. Irradiation for four hours at the same reactor power reduced the fluorescence intensity to 70%. A new emission peak in the long wave length region was found for the irradiation of a very large dose. (auth)

45340 LOCAL DISTRIBUTION OF ELECTRONS IN IRRADIATED AQUEOUS SOLUTION OF SODIUM HYDROXIDE AT 77°K. Yoshida, Hiroshi; Warashina, Tetsuo; Matsumoto, Keiko; Higashimura, Takenobu. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 274-8(Oct. 1968).

Power saturation phenomena in electron spin resonance were examined for electrons trapped in frozen aqueous solutions of sodium hydroxide irradiated at 77°K. From the saturation phenomena, paramagnetic relaxation times, T_1 and T_2 (spin-lattice and spin-spin relaxation time) were calculated. Local concentration of trapped electrons estimated from T_2 was much higher than their average concentration. This fact may indicate that the electrons are trapped inhomogeneously and spurs are formed. With increasing radiation dose, the average concentration increased, whereas the local concentration remained constant. This may indicate again the formation of spurs where the electrons are trapped. (auth)

45341 ELECTRON SPIN RESONANCE STUDY OF RADIATION INDUCED RADICAL IN DEOXYRIBONUCLEO-PROTEIN

SOLUTION. Yoshii, Giichi; Saito, Masahiro. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 279-83(Oct. 1968).

Studies were made on the nature of intermolecular energy transfer between DNA and histone in β-irradiated deoxyribonucleohistone (DNH) solution with or without bivalent metal ions. ESR measurements provided convincing evidence for free radical site transfer from DNA to histone in DNH solutions in the absence of Ca ions due to irradiation. (P.C.H.)

45342 CHANGE WITH TEMPERATURE OF THE ELECTRON SPIN RESONANCE SPECTRA OF $\sim CF_2CF_2$. TRAPPED IN IRRADIATED POLYTETRAFLUOROETHYLENE. Toriyama, Kazumi; Iwasaki, Machio (Government Industrial Research Inst., Nagoya, Japan). J. Phys. Chem., 73: 2929-24(Sept. 1969).

The change with temperature of the ESR spectra of $\sim CF_2\dot{C}F_2$ formed by the photolysis of peroxy radicals trapped in irradiated polytetrafluoroethylene (PTFE) was studied. Using oriented samples, the hyperfine tensors of the α-fluorine coupling were determined at 77°K and at room temperature. The principal values, $A_{\parallel}$ and $A_{\perp}$, are 225 and 17 G (assumed) at 77°K and 110 and 74 G at room temperature, respectively. The direction of $A_{\parallel}$ at 77°K is about 45° from the molecular-chain axis and at room temperature is along the chain axis. From the principal values and their directions, it was concluded that the temperature change of the spectra is caused mainly by the molecular motion around the chain axis, which may be related to the so-called room-temperature transition of PTFE. The structure of the radicals was also determined from the hyperfine tensor. The analysis of this temperature dependence of the hyperfine tensor gave further confirmation of identification of the radical $\sim CF_2\dot{C}F_2$ with the 3-line spectrum trapped in irradiated PTFE. (auth)

45343 FORMATION OF GLUTAMIC ACID BY γ-IRRADIATION FROM AQUEOUS MIXTURE OF α-KETOGLUTARIC ACID AND AMMONIA. Masuda, Kimiko; Rai, Tokan; Shinagawa, Mutsuaki (Osaka Univ.). Radioisotopes (Tokyo), 18: 350-3(Sept. 1969).

The formation of amino acid from α-ketoglutaric acid and aqueous ammonia solution by ^{60}Co γ-ray irradiation was studied. The irradiated solution was amlyzed by the electrophoretic method and amino acid analyzer. Glutamic acid was identified and estimated spectrophotometrically. The yield of glutamic acid was found to be dependent on the radiation dose and the concentration of α-ketoglutaric acid and ammonia. The effects of dose rate and temperature on the yield were not significant. The reaction mechanism was proposed as the reductive amination induced by the irradiation. (auth)

45344 RADIATION EFFECTS ON DNA–POLYPEPTIDE INTERACTIONS. Wheeler, C. M. (Univ. of Newcastle upon Tyne, Eng.). Biochim. Biophys. Acta, 182: 273-6(May 20, 1969).

Irradiation of polypeptides and of DNA separately was carried out, followed by irradiation of combination of DNA and polypeptide to observe the effect of irradiation on the association between the 2 molecules. Calf thymus DNA and protamine sulfate were dissolved in 1 mM NaCl, pH 7.0. After ^{60}Co irradiation 3 types of experiments were performed; (1) on irradiated DNA plus unirradiated polypeptide; (2) on mixed irradiated and unirradiated DNA's plus unirradiated polypeptide; (3) on unirradiated DNA plus irradiated polypeptide. After addition to polypeptides to unirradiated DNA, it was precipitated linearly with the amount of polypeptide added. Irradiated DNA (117 kRAD), by comparison, became much less precipitable as larger amounts of polylysine were added. Protamine and to a lesser extent polyarginine also precipitated smaller amounts of irradiated DNA. Competition experiments with equal amounts of unirradiated and irradiated DNA showed that irradiated DNA is precipitated preferentially. With both protamine and polyarginine a shoulder is observed on the precipitation profile, indicating that there is competition between unirradiated and irradiated DNA for the polypeptide, although eventually the slope is comparable to that of unirradiated DNA indicating its preferential precipitation. Irradiation of polylysine followed by addition to unirradiated DNA caused a decrease in the precipitating power of the polylysine after 45 kRAD. Addition of irradiated protamine to unirradiated DNA resulted in a pronounced diminution of the amount of DNA precipitated as the radiation dose increased. Irradiation of polyarginine had no effect on the amount of DNA precipitated. These results show definite changes in the patterns of DNA–polypeptide interactions caused by irradiation. These interactions are of interest owing to the possibility of basic polypeptides being concerned in genetic regulatory mechanism. (BBB)

45345 STUDIES ON THE PREPARATIONS OF ^{231}Th AND ITS RECOIL FROM ^{232}Th TARGET. Sakanoue, Masanobu; Matsuura, Masataka (Kanazawa Univ., Japan). Radioisotopes (Tokyo), 18: 305-11(Aug. 1969).

The separation of ^{231}Th from (natural) uranium sample and from the products of nuclear reactions such as $^{232}Th(n,2n)$ and $^{232}Th(\gamma,n)$ is examined in order to obtain a sample of ^{231}Th having a high specific activity. Some discussions are made as to the fact that ^{231}Th formed by nuclear reactions is affected by the existence of the Th series daughter nuclides. As ^{231}Th may recoil from the target materials in nuclear reaction, the enrichment of ^{231}Th hot atom formed by (n,2n) reaction is examined by physical or chemical methods. The ^{231}Th recoiling from Th target foil is caught by Al-tetron or mylar foils, and then purified from fission fragments by several chemical separation processes. The identification is made by ^{231}Th β decay curve and the range of recoiled ^{231}Th is estimated to be slightly larger than the thickness (10 $\mu g/cm^2$) of aluminum on Al-tetron foil. (auth)

45346 SATURATION STUDIES OF THE ELECTRON SPIN RESONANCE DUE TO TRAPPED ELECTRONS IN γ-IRRADIATED AND PHOTO-IONIZED ORGANIC GLASSES. Tsuji, Kozo; Williams, Ffrancon (Univ. of Tennessee, Knoxville). Trans. Faraday Soc., 65: 1718-26(July 1969).

Relaxation times for trapped electrons in organic glasses at 77°K were determined from the power saturation characteristics of the electron spin resonance. The spin-lattice relaxation time T_1 were longer than 10^{-3} sec, and the spin-spin relaxation time T_2 decreased with γ-irradiation dose. The saturation behavior of a photo-ionized glass was similar to that of the corresponding γ-irradiated glass when the comparison was made at nearly the same bulk concentration of trapped electrons. Evidence for a non-uniform distribution of paramagnetic species in these irradiated glasses was critically examined, and attention is directed to difficulties of interpretation. (auth)(UK)

45347 RADIOLYSIS OF ALIPHATIC KETONES. Akhtar, Syed Mohammad Shakeel. Saskatoon, Saskatchewan, Univ. of Saskatchewan, 1968. 281p.

Thesis.

The γ radiolysis of a number of aliphatic ketones in the liquid phase was investigated. Analysis of the products was carried out by gas chromatography. In the case of acetone the effect of the radical scavenger (DPPH) on some gaseous products was briefly studied. ESR spectra of some ketones irradiated at −195°C were examined. G-values were generally independent of absorbed dose; exceptions were olefins and aldehydes, and isopropyl alcohol from acetone. The G-values of most of the products were less than one. The results indicate that several mechanisms are operative. The ketone molecule RCOR′ splits into radical fragments RCO· and R′·. Radicals RCO· largely decompose into R· and CO, but may also participate in other reactions. The alkyl radicals mainly give rise to the corresponding alkanes, but a small fraction enters other reactions. Ketones possessing γ-hydrogen atoms undergo an intramolecular rearrangement-dissociation via a six-membered cyclic intermediate and give rise to an olefin and a lower ketone. For ketones possessing β-hydrogen atoms an intramolecular rearrangement involving a five-membered cyclic intermediate appears to be an important source of the aldehyde RCHO and an olefin. The formation of molecular hydrogen is attributed to hydrogen detachment, whereas the corresponding alcohol is presumably formed by addition of hydrogen atoms to the carbonyl group. Formation of minor products is explained by reactions such as combination, disproportionation and rearrangement. The ESR results indicate the formation of the radicals $CH_3\dot{C}OCH_2$ and $CH_3\dot{C}OHCH_3$ from acetone and of $CH_3\dot{C}OC(CH_3)_2$ from methyl-isopropyl ketone. (Diss. Abstr.)

45348 RADIOLYSIS OF PERFLUORODIMETHYLCYCLOHEXANE BY GAMMA PHOTONS, REACTOR RADIATIONS, OR FISSION FRAGMENTS. Scott, Thomas H.; Wethington, John A. Jr. (Univ. of Florida, Gainesville). Nucl. Sci. Eng., 38: 48-52 (Oct. 1969).

The radiolysis of perfluorodimethylcyclohexane, C_8F_{16} (indexed as decafluorobis(trifluoromethyl)cyclohexane) by gamma radiation, by reactor radiation, and by fission fragment radiation ($C_8F_{16}-UF_6$ solution exposed to reactor radiation) was studied. The principal products in the first two cases were dimeric molecules; however, small amounts of gaseous products including CF_4, C_2F_6, C_2F_6O, C_3F_8, and C_3F_8O were found. In the latter case, the principal products were CF_4, C_2F_6, and C_2F_6O. No polymeric materials were found. From the standpoint of the chemical nature of the products and of reaction kinetics, the effects of reactor and gamma radiation were indistinguishable. These same considerations, applied to fission-fragment radiolysis, supported the assumption that the C_8F_{16} molecule was shattered into tiny fragments which were then fluorinated to give simple fluorocarbon molecules. (auth)

45349 CHANGE OF SOME THERMODYNAMIC PROPERTIES AND STRENGTH OF IRRADIATED CELLULOSE FIBERS AFTER STORAGE. Usmanov, Kh. U.; Vakhidov, N. (Tashkent State Univ.). Vysokomol. Soedin., Ser. A, 11: 1501-6(July 1969). (In Russian).

Studies of integral heat of moistening, density, and tensile strength of cotton and viscose fibers before and after γ-irradiation in the presence of oxygen show that considerable change in the behavior is completely or partly restored after storage. It indicates the presence of relaxation processes in cellulose on γ-irradiation. (auth)

45350 A REVIEW OF THE RECENT DEVELOPMENTS IN PAINTING TECHNOLOGY. Asano, Hiroshi (Nippon Paint Co., Osaka). Toso Gijutsu, 8: No. 6, 37-48(May 1969). (In Japanese)

The following new methods of painting, not utilizing the flow character of liquids, are described with emphasis on the fundamental principle, equipment, and advantages: (1) painting by the electrodeposition technique; (2) painting in powders; and, (3) curing by electrons. In the electrodeposition process, the substance of paint is electrodeposited onto the material as the anode in a manner similar to metal plating. For powder painting, the technique of fluid soaking, and of electrostatic spraying and electrostatic soaking are described. In the curing by electrons, the material to be painted is polymerized on its surface by the irradiation to harden the material. Among the advantages of the process are the rapid hardening, simple operation, no need of heating, no evaporation of solvent, and no need for a catalyst or accelerator. (NSA of Japan)

45351 HIGHLY RADIATION-SENSITIVE TELOMERIZED POLYESTERS. D'Alelio, Gaetano F. (to PPG Industries, Inc.). U. S. Patent 3,455,802. July 15, 1969. Filed Mar. 2, 1966.

Telomerized diacrylyl polyesters were obtained by reacting dicarboxylic acids with polyhydric alcohols having end groups capped by acrylic and methylacrylic groups. These polyesters have the formula

$$CH_2=C(R')-COOR''O[OCRCOOR''O]_nOC-C(R')=CH_2$$

where n is 1 to 14, R is a single valence bond or a divalent unsaturated aliphatic hydrocarbon radical; R' is a divalent aliphatic hydrocarbon radical and R'' is hydrogen or methyl. These polyesters cure when subjected to relatively low doses of ionizing radiation. (Offic. Gaz.)

45352 HIGHLY RADIATION-SENSITIVE TELOMERIZED POLYESTERS. D'Alelio, Gaetano F. (to PPG Industries, Inc.). U. S. Patent 3,455,801. July 15, 1969. Filed Mar. 2, 1966.

Telomerized diacrylyl polyesters are obtained by reacting dicarboxylic acids with polyhydric alcohols having end groups capped by acrylic and methacrylic groups. These polyesters have the formula

$$CH_2=C(R'')-COOR'O[OCRCOOR'O]_nOC-C(R'')=CH_2;$$

where n is 1 to 14, R is a single valence bond or a divalent unsaturated aliphatic hydrocarbon radical; R' is a divalent aliphatic hydrocarbon radical and R'' is hydrogen or methyl. These polyesters cure when subjected to relatively low doses of ionizing radiation. (Offic. Gaz.)

45353 ESR STUDIES OF RADICAL FRAGMENTS PRODUCED IN X-IRRADIATED DISODIUM SUCCINATE. Bales, Barney L. (Univ. of Colorado, Boulder); Schwartz, Robert N.; Hanna, Melvin W. J. Chem. Phys., 51: 1974-8(Sept. 1, 1969).

The room-temperature stable paramagnetic species in x-irradiated disodium succinate was found to be $^-O_2\dot{C}CHCH_3$, rather than $^-O_2CCH_2\dot{C}H_2$ as proposed previously by others. This result is in marked contrast to that found in x-irradiated succinic acid, where $HOOOC\dot{C}HCH_2COOH$ is the principal fragment. This difference in the radiation damage behavior in succinic acid and its disodium salt is attributed to differences in molecular configuration within the crystal lattice, which allows intermolecular hydrogen-atom transfer to occur in succinic acid, but not in disodium succinate. In the latter compound intramolecular transfer occurs instead. A mechanism for radiation damage in the dicarboxylic acids is proposed. (auth)

45354 PULSE RADIOLYSIS OF BENZENE–CYCLOHEXANE MIXTURES. Thomas, J. K.; Mani, I. (Argonne National Lab., Ill.). J. Chem. Phys., 51: 1834-8(Sept. 1, 1969).

The radiolysis of benzene and mixtures of benzene and cyclohexane have been studied by the nanosecond pulse radiolysis technique. In pure benzene, two short-lived transitory species were observed with absorption maxima at 320 mμ and $t_{\frac{1}{2}}$ = 112 nsec and 515 mμ and $t_{\frac{1}{2}}$ = 18.5 nsec. The effects of temperature and dilution in C_6H_{12} showed that the 515-mμ peak was associated with the excimer of benzene. The effects of added solutes and of benzene dilution in C_6H_{12} suggested that the 320-mμ absorption was associated with a free radical which was formed by the reaction of a benzene triplet with benzene. The effects of benzene concentration on the excited singlet and triplet yields and on the reaction of the ionic species were also studied. It was found that the geminate-ion recombination time was shorter in benzene than in C_6H_{12}, and that ion recombination was a major source of energy transfer in the radiolysis of benzene/C_6H_{12} mixtures. (auth)

45355 METHOD OF COATING AND COMPOSITIONS THEREFOR. (to Ford Motor Co., Ltd.). British Patent 1,162,721. Aug. 27, 1969. Priority date Aug. 13, 1965, United States.

A coating may be applied to a substrate by applying a film of a paint binder consisting of a film-forming solution of a urethane-modified resin containing one or more liquid vinyl monomers polymerizable with the resin by ionizing radiation. The resin has a molecular weight in excess of 1000 and contains 0.5 to 3 vinyl unsaturation units/1000 of molecular weight. The substrate may be wood or metal, and the polymerization is achieved by a beam of electrons. (B.L.M.)

Radiochemistry

45356 (AD-687275) THE MECHANISMS OF FALLOUT PARTICLE FORMATION. Annual Progress Report for Period Ending March 1967. Bloore, Ernest W.; Benck, Ralph F.; DeTuerk, John J. Jr.; Yannopoulos, L. N.; Hill, Charles G. Jr. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Apr. 1967. 75p. (NDL-SP-16). CFSTI.

Reactions between gaseous fission and activated elements and solid substrate materials were studied. The high-temperature properties of gaseous fission products and the phenomenon of gaseous fission products colliding with gaseous, liquid, or solid materials are reported. The study of gaseous fission elements reacting with solid target materials included sticking phenomena, sticking coefficient measurements, gaseous species, and high-temperature effects on kaolin and silica. (USGRDR)

45357 RADIOCHEMICAL BREAK-DOWN OF ^{131}I LABELLED L-THYROXINE PREPARATIONS. A STUDY OF THE INFLUENCE OF INCREASED SPECIFIC ACTIVITY AND TIME OF STORAGE. Hoeye, Age (Institutt for Atomenergi, Kjeller, Norway). Acta Chem. Scand., 23: 1040-4(1969).

The radiochemical stability of ^{131}I-labeled L-thyroxine was investigated. The effects of increased specific activity and time of storage on rate of decomposition in samples with specific activities from around 10 mCi/mg to 100 mCi/mg and with a storage time up to eight weeks were studied. (auth)

45358 MECHANISM OF FORMATION OF NONEQUILIBRIUM RATIOS BETWEEN NATURAL RADIOACTIVE ISOTOPES IN URANIUM- AND THORIUM CONTAINING NATURAL COMPOUNDS. Chalov, P. I. At. Energ. (USSR), 27: 26-31(July 1969). (In Russian).

Empirically established regularities of nonequilibrium ratio formation between natural radioactive isotopes (NRI) in microdamages of natural radioactive compounds cannot be explained in terms of the accepted conceptions. In order to ascertain the mechanism new experiments with U-isotopes were carried out. It was found that ^{234}U and ^{238}U separation in microdamages is associated with the formation of specific structural defects. On the other hand the correlation between relative ^{234}U enrichment of microdamages and hexavalent fractions of natural U oxides was established. Determining the NPI radiation effects in solids showed that nonequilibrium ratios between NRI in radioactive natural compounds are sequences of displacement spikes caused by recoil atoms, formed by α decay. NRI activities ratio obtained for an elementary displacement spike allows the empirically established basic NRI separation regularities characteristic of natural radioactive compounds microdamages, as well as some other phenomena, to be explained. (auth)

45359 REMARKS ON THE ASSAY OF ^{99m}Tc IN MEDICAL RADIOISOTOPE LABORATORIES. Husak, V.; Kleinbauer, K. (Palacky Univ., Olomouc, Czech.). Isotopenpraxis, 5: 190-5 (May 1969).

Various possibilities of determining the activity of ^{99m}Tc in medical radioisotope laboratories are discussed. As the assay of ^{99m}Tc from the known activity of ^{99}Mo is not always possible relative methods using the ^{57}Co standard and other suitable isotopes are recommended. Even in the case that the ^{57}Co standard is not available the corrections presented make possible the determination of the ^{99m}Tc activity from the photopeak of the scintillation spectrum. Routine measurements of ^{99m}Tc in radioisotope diagnosis over a wide range of activities using a scintillation counter calibrated by a known amount of ^{99m}Tc are shown to be very useful and reliable. (auth)

45360 REACTIONS OF ACCELERATED CARBON IONS AND ATOMS WITH BENZENE. PRODUCT DISTRIBUTION AS A FUNCTION OF CHARGE AND KINETIC ENERGY. Pohlit, Helmut M.; Lin, Tz-hong; Erwin, Wallace; Lemmon, Richard M. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 91: 5421-4(Sept. 24, 1969).

Monoenergetic beams of $^{14}C^+$ ions (from 15- to 0.1-keV kinetic energy), and beams of 5- and 0.5-keV carbon atoms, were allowed to impinge on a target of solid benzene at −196°C. About 28% of the ions striking the benzene were accounted for as identified C_2, C_6, C_7, C_8, C_{12}, and C_{13} hydrocarbons. The appearance of the known products was essentially unaffected by either the kinetic energy or the charge state of the impinging ions or atoms. (auth)

45361 HOT-ATOM CHEMISTRY OF $^{14}C^+$ IN BENZENE. PARTIAL DEGRADATIONS AND SUGGESTED MECHANISMS. Pohlit, Helmut M.; Lin, Tz-hong; Lemmon, Richard M. (Univ. of California, Berkeley). J. Amer. Chem. Soc., 91: 5425-9 (Sept. 24, 1969).

Seven ^{14}C-products (toluene, cycloheptatriene, phenylacetylene, "U-2," biphenyl, diphenylmethane and phenylcycloheptatriene) from hot-atom reactions of ^{14}C ions of 5-keV kinetic energy in solid (−196°) benzene were partially degraded. The results indicate the formation of the intermediate ^{14}C-carbenes, methylene, benzylidene, and cycloheptatrienylidene, and reactive ^{14}C-containing fragments, particularly a C_2 species. Cycloheptatrienylidene and cycloheptatriene apparently undergo extensive isomerization during, or immediately following, their formation. This isomerization is compared with other known modes of isomerization of cycloheptatriene and found to be best represented as 1,2-hydrogen shifts. It appears that, in the system under investigation, a mechanism different from the thermal has to be assumed. (auth)

Separation Processes

Refer also to abstracts 45182, 45241, 45262, 45296, 45448, 45496, 45498–45500, 45983, 46332, and 47170.

45362 (ANL-7520(Pt.1), pp 271-7) PREPARATION OF HIGH-PURITY SODIUM FOR CHEMISTRY STUDIES. McKisson, R. L.; Eichelberger, R. L. (Atomics International, Canoga Park, Calif.).

The use of hot gettering followed by vacuum distillation for the purification of sodium is described. The gettering reduces the oxygen content (and the C and N contents, too) in the Na, which can then be separated from its metallic impurities by distillation. The sodium-purification unit tested for preparing highly purified Na for use in chemistry studies was found to be quite effective. The impurity content of its product was very low, and the material was well-suited for planned studies. An anomaly did exist, however, in that the C content of the Na involved appeared to approach an asymptotic value of about 8 ppM. No suitable explanation for this observation was apparent. (P.C.H.)

45363 (ANL-Trans-770) PROSPECTIVES OF PROCESSING HIGHLY IRRADIATED FUEL ELEMENTS BY THE EXTRACTION METHOD. Shevchenko, V. B. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). Translated for Argonne National Lab., Ill., from a Russian paper. 17p. Dep. CFSTI.

Characteristics of fuel elements of prospective thermal and fast neutron reactors are discussed. The principles of decladding highly irradiated fuel elements and dissolution of the fuel are considered. Preparation of the solution and extractant, selection of extraction conditions, and behavior of some of the fission products are described. (M.C.G.)

45364 (CONF-690815-4) THE SOLVENT EXTRACTION OF URANIUM FROM SLURRIES. Mineral Beneficiation Paper No. 5. Byerlee, H. W. (Associated Mineral Consolidated Ltd., Southport (Australia)). Apr. 14, 1969. 28p. Dep. CFSTI (U. S. Sales Only).

From Conference of the Australian Institute of Mining and Metallurgy, Sydney, Australia.

A study was made of the flow of a dense slurry through a packed tower in which the continuous phase was kerosene. The grid type packing, which was preferentially wetted by the slurry, had slats inclined at an angle of 30°, to the horizontal. On the surface of the slats there were uniformly spaced longitudinal indentations. These were of a height slightly less than the film thickness and divided the slurry discharging from the bottom of the slats into a number of uniform streams. When slurry entered the tower it was distributed by means of a troughs and weirs type distributor. Because of the relatively high slurry velocities that occur at the entry region, it was necessary to have the distributor and the first two grids above the solvent level. The interface at the bottom of the tower was located at the mid-point of the bottom grid, so that the slurry entered the interface as a continuous film across the full width of the slats. Using the above system, stable flow with low entrainment was achieved at slurry flow rates of 3.4 msl/cm/sec. This would be equivalent to a flow rate of 177 gallons per minute through a tower of cross-section 4 ft 4 in. by 4 ft 10 in., or 1200 tons per day of solids of specific gravity 2.6 when the pulp density was 65 per cent. Previous tests indicate that a total tower height of about 30 ft would be required for a recovery of better than 99 per cent. (auth) (Australia)

45365 (DOCKET-50201-17) WEST VALLEY REPROCESSING PLANT. License No. CSF-1: Technical Specifications, Change No. 11. (Nuclear Fuel Services, Inc., West Valley, N. Y. New York State Atomic and Space Development Authority, New York). Sept. 17, 1969. 46p. Dep. CFSTI.

Information is given in support of a request for authorization of operation of the West Valley Reprocessing Plant. Technical specifications for license CSF-1 include: plant description, definitions, authorized materials, safety limits, minimum conditions for operation, surveillance requirements, and administrative requirements. (M.C.G.)

45366 (DOCKET-50201-18) WEST VALLEY REPROCESSING PLANT. License No. CSF-1; Request for Extension of Expiration Date. (Nuclear Fuel Services, Inc., West Valley, N. Y. New York State Atomic and Space Development Authority, New York). Sept. 23, 1969. 9p. Dep. CFSTI.

Information is submitted in support of a request for extension of the expiration date of provisional operating license, dated March 17, 1969. The estimated net cash requirements for 5 years, 1969 through 1973, are $20,185,000. Anticipated cash receipts, other than from operating revenues, are listed. Revenues and expenses of the Erwin Plant are discussed. A Nuclear Fuel Services, Inc., consolidated balance sheet as of June 30, 1969, is included. (M.C.G.)

45367 (JUL-591-DE) THE INFLUENCE OF CATALYSTS ON THE DECOMPOSITION OF PEROXODISULFATE AND PEROXOMONOSULFATE IN AQUEOUS SOLUTION. Schulze-Rettmer, R.; Buchheim, B.; Schlenter, W. (Kernforschungsanlage, Juelich (West Germany). Abt. Dekontamination). Mar. 1969. 92p. (In German). Dep. CFSTI (U. S. Sales Only).

The influence of homogeneous catalysts on the decomposition of peroxydisulfates in radioactive wastes was investigated. Silver (I), Cu(II), Fe(II), Mn(II), W/Co(II), and organic proton donors were studied as catalysts. (M.C.G.)

45368 (KFK-958) ^1H AND ^{31}P NMR INVESTIGATIONS OF THE EXTRACTION CHARACTERISTICS OF ORGANOPHOSPHORUS COMPOUNDS. III. THE EXTRACTION OF HNO_3 AND URANYL NITRATE BY TRIOCTYLPHOSPHINE OXIDE. Ammon, R. v.; Dressler, P.; Troye, W. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Heisse Chemie). May 1969. 30p. (In German). Dep. CFSTI (U. S. Sales Only).

In the extraction of H_2O, HNO_3, and $UO_2(NO_3)_2$ by TOPO, the influence of concentration on the chemical shift of the α-CH_2 protons, the phosphorus atoms, and the HNO_3/H_2O protons was investigated and compared with results for TBP. It was found that TOPO combines with H_2O to form a stoichiometric 1:1 adduct. Most likely a compound also exists with a ratio $C_{H_2O}/C_{TOPO} < 1$, possibly $H_2O \cdot 2TOPO$. The compound $TOPO \cdot HNO_3$ is formed with a hydrogen bridge. The reaction between TOPO and $UO_2(NO_3)_2$ yields $UN \cdot 2TOPO$. (M.C.G.)

45369 (ORNL-4396, pp 269-301) MOLTEN-SALT PROCESSING AND PREPARATION. (Oak Ridge National Lab., Tenn.).

Topics covered include: flowsheet analysis (proposed reductive extraction processing flowsheet for a single-fluid MSBR, protactinium and rare earth removal from single-fluid MSBR, and material balance calculations); measurement of distribution coefficients in molten-salt–metal systems (extraction of U, Zr, Pa, and Pu from single-fluid MSBR fuels, solubility of Pa in Bi, extraction of Th and rare earths from single-fluid MSBR fuels, metal transfer process studies, and effect of other components on the solubility of Th in Bi); engineering development of process operations (electrolytic cell development, reductive extraction engineering studies, simulated molten-salt–liquid-bismuth contactor studies, design of a continuous electrolytic cell testing system, and experimental facilities for reductive extraction development work); and distillation of MSRE fuel carrier salt. (D.H.M.)

45370 (STI/DOC-10/89) CHEMICAL TREATMENT OF RADIOACTIVE WASTES. Technical Reports Series No. 89. Pottier, P. E. (comp.) (International Atomic Energy Agency, Vienna (Austria)). 1968. 80p. IAEA $2.50. Dep.

Chemical precipitation by coagulation-flocculation and sedimentation is considered as a method for treatment of radioactive waste. Topics covered include: principles of coagulation-

flocculation and sedimentation, processes and equipment, conditioning and disposal of flocculation sludge, sampling, laboratory work, and factors governing the selection of processes. (M.C.G.)

45371 (UJV-2204-Ch) RADIOCHEMICAL ISOLATIONS OF SOME NEUTRON-DEFICIENT ISOTOPES OF OSMIUM AND MERCURY. Vobecky, M.; Fiser, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). July 1969. 21p. Dep. CFSTI (U. S. Sales Only).

The isolation of carrier-free neutron-deficient activities of osmium (^{182}Os, ^{183}Os, ^{185}Os) and mercury (^{182}Hg, $^{193m+193}$Hg, ^{194}Hg, $^{195m+195}$Hg, ^{203}Hg) and preparation of sources for measurement of conversion electron spectra are discussed. The preparation of osmium is based on distillation from nitric acid medium and extraction of distillate by tetrachloromethane. Mercury was extracted as a dithizonate complex from a mineral acid–EDTA–sulphite medium. The carrier-free activities of platinum, thallium, yttrium, thulium, ytterbium, and lutetium were also isolated and identified from the mixture of spallation products of lead. (auth)

45372 A ^{103m}Rh GENERATOR WITH POTENTIAL MEDICAL USEFULNESS. Landolt, R. R.; Kudva, Shanthi P. (Purdue Univ. Lafayette, Ind.). Radiochem. Radioanal. Lett., 1: 373-8(Sept. 13, 1969).

The separation of ^{103m}Rh from ^{103}Pd was performed by passing 0.9% NaCl through a Dowex 1-X8 ion exchange column containing an equilibrium mixture of ^{103}Pd–^{103m}Rh. Although the yield was low, the ^{103m}Rh was pure and the generator system appears to have potential medical usefulness. (auth)

45373 RADIOCHEMICAL SEPARATION OF GALLIUM BY AMALGAM EXCHANGE. Ruch, R. R. (Illinois State Geological Survey, Urbana). Anal. Chim. Acta, 47: 425-9(Oct. 1969).

An amalgam-exchange separation of radioactive gallium from a number of interfering radioisotopes was developed. A dilute (ca. 0.3%) gallium amalgam is agitated with a slightly acid solution of $^{72}Ga^{3+}$ containing concentrations of sodium thiocyanate and either perchlorate or chloride. The amalgam is then removed and the radioactive gallium stripped by agitation with dilute nitric acid. The combined exchange yield of the perchlorate–thiocyanate system is 90 ± 4% and that of the chloride–thiocyanate system is 75 ± 4%. Decontamination yields of most of the 11 interfering isotopes studied were less than 0.02%. The technique is applicable for use with activation analysis for the determination of trace amounts of gallium. (auth)

45374 RESEARCH ON THE TREATMENT OF IRRADIATED FUELS IN FRANCE. Sauteron, J. (CEA, Paris). Ind. At., 13: No. 7-8, 37-48(1969). (In French).

Research conducted by the C.E.A. Chemistry Department on the processing of irradiated fuels by solvent extraction processes is reviewed. Research on the halide volatilization process, the vitrification of fission products, and the evaluation of transuranic elements which are undergoing rapid development in the applications field is also discussed. The most important recent results are: the processing of the first irradiated assemblies from the fast neutron reactor Rapsodie at the La Hague AT1 plant, the demonstration of the volatilization process in the presence of high activities, the production and use of 5 g of plutonium-238, and the turning over of the Marcoule pilot vitrification plant to active work. (auth)

45375 METHOD FOR THE ENRICHMENT OF DEUTERIUM. Klein, Fritz S.; Bar-Eli, Kedma (to Yeda Research and Development Co., Ltd.). U. S. Patent 3,457,041. Priority date Aug. 25, 1961, Israel.

A bi-thermal isotopic enrichment process consists of exchange between a gaseous stream of hydrogen and a liquid stream containing an exchange agent and a catalyst for stripping D from the gaseous phase. The exchange agent is an aliphatic amine having a formula RR'NH where R is a hydrogen or lower alkyl radical having from 1 to 5 carbon atoms, and R' is a lower alkyl radical having from 1 to 5 carbon atoms. The catalyst is an alkali metal amide having a formula MNRR' where M is an alkali metal atom and R and R' are the same as in the exchange agent. (Offic. Gaz.)

45376 THE ISOTOPIC FRACTIONATION OF HYDROGEN IN WATER–HYDRONIUM ION SYSTEM. Znamirovschi, V. (Univ., Cluj). Rev. Roum. Phys., 14: 175-81(1969).

The equilibrium curve for the deuterium content and the distribution curves for the isotopic molecular species were calculated by taking into account the complex exchange equilibrium in the water–hydronium ion system. (auth)

45377 PROCESS FOR THE PRODUCTION OF ISOTOPES. Tannenberger, Helmut; Schachner, Herbert (to Compagnie Francaise de Raffinage). U. S. Patent 3,451,911. Priority date Dec. 2, 1964, France.

In a process for enriching a stream of oxygen in the heavier isotopes, oxygen consisting of at least two different weight isotopes is introduced into a cathode compartment of a series of electrolytic cells. Part of the oxygen is ionized by electrochemical reduction at a cathode of a cell at a working temperature between 600° and 1000°C. The oxygen ions are conveyed through an electrolyte, which contains ZrO_2, ThO_2, or HfO_2 as a base oxide and an oxide selected from the group consisting of Yt_2O_3, Al_2O_3, CaO, ScO, and Y_2O_3, to an anode of a cell. The electrolyte is permeable to oxygen ion but is impermeable to gases in the electrolyte cell. Electrochemically oxidized oxygen ions, impoverished in heavy isotopes, are conveyed away from the anode, and oxygen enriched in heavy isotopes remaining in the cathode zone is collected. A stepwise enrichment process is achieved by using a number of cells and conducting the enriched oxygen from one cell to the cathode compartment of the next cell. (Offic. Gaz.)

45378 PROCESS FOR THE FIXATION OF HIGH LEVEL RADIOACTIVE WASTES. Stukenbroeker, George L.; Suriani, Ernest (to National Lead Co.). U. S. Patent 3,451,940. Filed Mar. 22, 1967.

Radioactive waste solutions can be incorporated into silicate-type minerals by a thermite reaction. Nitrate solutions of radioactive materials are treated with H_2SO_4, evaporated to form a sulfate mass, which is then reacted with Si or Si and SiO_2 as a thermite mixture to form a polysilicate mass highly insoluble to water leaching. (Offic. Gaz.)

45379 SEPARATION OF ZIRCONIUM FROM HAFNIUM BY LIQUID–LIQUID EXTRACTION WITH CYCLOHEXANONE. Otsuka, Takeshi; Miyazaki, Hideo (Nippon Mining Co., Saitama, Japan). Denki Kagaku, 37: 475-81(July 1969). (In Japanese).

In the cyclohexanone–ammonium thiocyanate–HCl system, the distribution coefficient of Zr and Hf was large, their separation factor was only 3 to 5. By adding suitable amounts of ammonium sulfate to the aqueous solution, the distribution coefficient of Zr was lowered, and the separation factor could be increased without decreasing the distribution coefficient of Hf. Also, by adding suitable amounts of ammonium acetate to the aqueous solution, the distribution coefficient of Hf was increased selectively, and the separation factor could be increased. A theoretical explanation for the effect of ammonium sulfate on Zr–Hf separation was advanced from a relationship between the dissociation constant of $Zr(SO_4)_2$ or $Hf(SO_4)_2$ and the distribution coefficient of $Zr(CNS)_4$ or $Hf(CNS)_4$. On the other hand, two-phase separation in continuous operation of this system was difficult because of small differences in their specific gravity between cyclohexanone and aqueous solutions. But a rapid separation of the two phases were accomplished by an extraction with mixed solvent such as cyclohexanone–methyl isobutyl ketone or –butyl acetate or –cyclohexane, instead of the extraction with cyclohexanone only. Cyclohexanone was considerably soluble in the aqueous solutions, but it could be recovered from the aqueous solution containing cyclohexanone by another liquid–liquid extraction process with cyclohexane. (NSA of Japan)

45380 ON THE ISOTOPIC PARTITION EQUILIBRIA OF SULFUR BETWEEN COEXISTING MINERALS. Sakai, Hitoshi (Okayama Univ., Japan). Geochem. J. (Nagoya), 1: 28-30 (Dec. 1967). (In Japanese).

Isotopic exchange equilibria of S are discussed on the basis of physicochemical properties of the main elements in minerals. Reduced partition function ratios (or elementary separation factor) of SO_4^{2-}, anhydrite, gypsum, celestite, baryte, anglesite, H_2S, HS^-, pyrite(1/2), sphalerite, and galena are summarized in the range of 300 to 500°K. In sulfate mineral, δ_S of minerals, except $PbSO_4$, generated around ordinary temperature is ca 1 to 2‰ larger than that of mother liquid, and δ_S's of minerals in equilibrium at hydrothermal temperature are all equal and moreover are equal to that of SO_4^{2-} in mother liquid. From C_v/C_v^w and the volume compressibility, $\delta_{S(pyrite)} > \delta_{S(sphalerite)} > \delta_{S(galena)}$ is expected, and the assumption agrees with observations in many mineral deposits. Since isotopic equilibrium of H_2S in aqueous solution varies with pH, sphalerite and pyrite crystallized from alkaline solution at 500°K enriches ^{34}S considerably. Accordingly δ_S in solution decreases with the degree of the crystallization of the sulfide. In a thermal solution with a pH that makes possible the presence of HS^- and H_2S, the decrease of δ_S in mother liquid due to the crystallization of these sulfides was very small. Isotopic equilibrium in SO_4^{2-}–H_2S_{aq}–sulfide system is discussed. (NSA of Japan)

45381 METHODS AND PLANTS FOR THE REPROCESSING OF NUCLEAR FUELS. Cass, Anna F. Com. Naz. Energ. Nucl., Notiz., 15: No. 6, 73-92(June 1969). (In Italian).

An extensive review of the various methods for the chemical reprocessing of nuclear fuels and of the plants existing in various countries is presented. The specifications of such plants are given in tabulated form. (auth)

45382 SEPARATION OF HEAVY WATER IN PHASE EQUILIBRIA INVOLVING PURE WATER OR SALT-WATER SYSTEMS. Johansson, Mats; Holmberg, Karl Erik (Aktiebolaget Atomenergi, Studsvik, Sweden). Acta Chem. Scand., 23: 765-81(1969).

Separation factors for deuterium on equilibration of ice or vapor with liquid water and with some salt solutions were determined, and also factors for equilibrium between some salt hydrate crystals and their saturated solutions. Some separation factors were calculated from vapor pressures and known thermodynamic data. Comparisons are made with previously published data. For equilibrium in the system ice-vapor-solution the three separation factors are found to be closely compatible which lends support to the claim that the experimental measurements are fairly reliable. The separation factor for the freezing of ice from a salt solution may be considerably larger than that for freezing from pure water. (auth) (Denmark)

45383 PURIFICATION OF LIQUID-METAL COOLANTS BY IMPURITY CRYSTALLIZATION OUT OF SOLUTION. Ivanovskii, M. N.; Arnol'dov, M. N.; Shmatko, B. A. At. Energ. (USSR), 27: 5-9(July 1969). (In Russian).

The main conditions necessary for effective operation of impurity cold traps were determined. The first condition demands that the temperature field over the trap length relative to the apparatus input should satisfy the inequality $d^2t/dx^2 < 0$. The maximum temperature gradient should be at the place of impurity accumulation, the zones of both accumulation and crystallization must be combined. The second condition requires minimum temperature to be maintained in the crystallization zone and the cooling zone to be transferred as far as the crystalline layer front is transferred when the impurities are accumulated. The third condition requires provision of the convective transfer of impurities to the crystallization place, to provide an intensive mixing in the crystallization zone. It is shown that the simple one-zone trap satisfying the requirements provides high speed and maximum purification depth. Such a trap has a large capacity for impurities accumulated (for sodium oxides—more than 60%). The trap would not be plugged up at the input and would remain quite effective even at great emergency contamination of the coolant up to the concentrations that are dozens of times more than the saturation concentration at the trap input. The trap does not release impurities into the circuit with the rate increase within it. Analysis of the third zone through trap operation (with cooling, settling, and filtration zones) reveals that the fulfilment of the conditions stated above results in improvement of the efficiency and operation characteristics of traps. The development of the 3-zone cold trap leads to its simplification to a one-zone trap. (1 figure, 6 references.) (auth)

45384 THE PROBLEMS OF ISOLATING TRACER ISOTOPES FROM A BULK OF LABELLED MATERIAL. Urbanski, T. S.; Wezranowski, E.; Kosciukowa, B.; Radwan, M. Isotopenpraxis, 5: 181-6(May 1969). (In German).

The problems of separating tracer isotopes, particularly from a bulk of labeled material, for purposes of direct radiometric measurement or activation analysis are considered. Moreover, the possible processes of treating labeled samples are discussed along with conditions the analytical methods have to fulfill especially with respect to the separation of low amounts of tracer isotopes from chemically analogous materials. Promising techniques of separation such as extraction by organic solvents, ion exchange, coprecipitation, are briefly discussed, and the field of using them is estimated. (auth)

45385 ON THE ENRICHMENT OF THE STABLE SULFUR ISOTOPES BY SOLID-LIQUID EXCHANGE USING ION-EXCHANGERS. Missbach, D. (Inst. for Stable Isotope, Berlin). Isotopenpraxis, 5: 195-202(May 1969). (In German).

The enrichment of the stable isotope ^{34}S by frontal or band displacement chromatography using the ion exchange resins Wofatit L 150, SBW, and SBK is described. In the isotopic exchange system HSO_3^-/SO_2, the methods and operating parameters were optimized. (M.C.G.)

45386 ELUTION SYSTEM OF THE RARE EARTHS WITH EDTA ELUENT. Hagiwara, Zenzi (Tohoku Univ., Sendai). J. Phys. Chem., 73: 3102-8(Sept. 1969).

In order to explain theoretically column elution under a steady state, elutions of adjacent rare earths (praseodymium and neodymium) were performed at 20°C, employing different concentrations of EDTA eluent and variously cross-linked cation exchange resins. With the aid of derived equations, the plate height contribution due to either film or particle diffusion was found by a curve-fitting method. The plate height values found from rate theory were compared with those obtained on the basis of countercurrent extraction. The differences were small. It was concluded that the elution of rare earths with dilute EDTA eluent from standard or lower cross-linked resin was mainly controlled by film diffusion. The rare earth elution system involving Dowex 50W-X16 was mainly dominated by particle diffusion. (auth)

45387 CONCENTRATION OF THE RARE EARTH ELEMENT IMPURITIES DURING THE ANALYSIS OF ELEMENTS OF THE CERIUM SUBGROUP BY THE ANION-EXCHANGE CHROMATOGRAPHIC METHOD. Molnar, F.; Lebedev, N. A. (Central Inst. of Physical Research, Budapest. Joint Inst. of Nuclear Research, Dubna, USSR). Zh. Anal. Khim., 24: 1152-5(Aug. 1969). (In Russian).

The separation of rare earth impurities from the base elements of the cerium subgroup by means of an anion-exchange chromatographic method using neutral methanol solutions of ammonium nitrate as an eluent was investigated. Conditions were found for concentrating lanthanides as impurities in neodymium and gadolinium. The concentrates were obtained in a form which is suitable for analysis by any analytical method. (auth)

45388 FLOODING BEHAVIOR, OPTIMUM WORKING POINT, AND EFFICIENCY OF SEPARATION OF PACKED COLUMNS. Lentz, H. (Univ., Goettingen, Ger.). Chem.-Ing.-Tech., 41: 855-61(Aug. 1968). (In German).

The efficiency of separation of packed columns as a function of throughput was determined for columns packed with glass Raschig rings (5 mm) and with wire-mesh packing (2 mm) using H_2O-D_2O and heptane—methylcyclohexane as test mixtures. Formulas are given for the calculation of the maximum rate of evaporation which are also valid for water. Furthermore, it was found that the optimum working point of a column corresponds to the maximum value of material exchange and that the packing and mixtures can be numerically characterized by this value. In the case of Raschig rings the optimum working point lies in the flooding point and for wire-mesch packing between 81 and 88% of the greatest loading. The separation efficiency as a function of the rate of evaporation is discussed on a qualitative basis. (auth)

45389 OSNOVY DEZAKTIVATSII VODY. (Water Deactivation Procedures). Kuznetsov, Yu. V.; Shchebetkovskii, V. N.; Trusov, A. G. Moscow, Atomizdat, 1968. 322p.

Radiochemical aspects of deactivation of radioactive water, the source and concentration of radioisotopes, and permissible doses are discussed in the first chapter. The second chapter analyzes deactivation of drinking water by coagulation with iron and aluminum salts and by filtration through sand filters. The third and the fourth chapters deal with the perspectives and efficiency of deactivation of water by chemical precipitation, ion exchange, electrodialysis, distillation, and biological deactivation. 609 references. (R.V.J.)

45390 SEPARATION OF RADIOCARBON FROM RADIOMETALS IN BIOLOGICAL SAMPLES. Nigrovic, Vladimir; Jarvis, Arthur N. (Univ. of Minnesota, Minneapolis). Anal. Biochem., 30: 403-12(Sept. 1969).

Methods and procedures are described for both wet and dry oxidation of relatively large biological samples, including bone. These methods utilize a simple and inexpensive apparatus that eliminates the transfer of aliquots and permits the separation of radiocarbon from radiometals. (auth)

45391 USE OF A "SELF-CLEANING" OVEN TO CLEAN LIQUID SCINTILLATION VIALS AND OTHER GLASSWARE. Kushinsky, Stanley; Paul, Wellington (Harbor General Hospital, Torrance, Calif. Univ. of California, Los Angeles). Anal. Biochem., 30: 465-7(Sept. 1969).

A self-cleaning oven gave good results in the removal of radioactive organic contaminants from scintillation vials and other glassware. The heat generated during the cleaning cycle (approximately 470°C) was sufficient to volatilize or combust the organic residue on glassware washed by a relatively simple procedure. (J.G.B.)

45392 SEPARATION OF SMALL AMOUNTS OF ^{229}Th FROM LARGE QUANTITIES OF ^{233}U. Jenkins, I. L.; Lidington, Dallas E.; Wain, A. G. (Atomic Energy Research Establishment, Harwell, Eng.). J. Appl. Chem. (London), 19: 213-17(Aug. 1969).

The separation of 6.6 mg of ^{229}Th from 400 g of ^{233}U is described. The process involves the preferential extraction of ^{233}U from an aqueous solution in nitric acid into dibutyl carbitol and the purification of the thorium left in the aqueous phase by ion exchange. Thorium recovery was 91% and the thorium was decontaminated from uranium by a factor of at least 4×10^3. (auth)(UK)

45393 METHOD FOR RECOVERING ^{210}Po FROM Bi. Schulz, Wallace W.; Schiefelbein, Gary F.; Bruns, Lester E. (to U. S. Atomic Energy Commission). U. S. Patent 3,463,739. Aug. 26, 1969.

A method for recovering ^{210}Po from irradiated Bi involves the use of both pyrochemical and liquid–liquid solvent extraction steps. Molten Bi containing the ^{210}Po is contacted at 400 to 500°C in an inert atmosphere with NaOH. After separation of the liquid phases, the NaOH phase containing the ^{210}Po is dissolved in HNO_3. The ^{210}Po is extracted from the HNO_3 solution with dibutybutyl phosphonate in kerosene. (B.L.M.)

45394 METHOD OF REMOVING RADIOIODINE VALUES FROM A GASEOUS MEDIUM. **Ward, W. T.; Adams, R. E. (to United States Atomic Energy Commission). U. S. Patent 3,466,137. Sept. 9, 1969.**

Gaseous radioiodine values, particularly methyl iodide, are removed from a gaseous atmosphere containing these values by contacting the gas atmosphere with an aqueous solution containing ammonium sulfide. (AEC)

45395 PROCESS OF ISOTOPIC ENRICHMENT BY BI-THERMAL EXCHANGE NH_3–H_2. **Courvoisier, P.; Lambert, I. (to Commissariat a l'Energie Atomique). Canadian Patent 813,262. May 20, 1969. Priority date June 1965, France.**

An improved process of isotopic enrichment by countercurrent exchange between liquid NH_3 and gaseous H_2 is described. There are two exchange zones at different temperatures with a catalyst assisting the exchange. Gaseous H_2 contacts a mixture composed of liquid NH_3 having an ether dissolved in it and also potassium amide. The ether and the amide must be free of oxidizing impurities. Several different ethers are named as being satisfactory for the process. (F.S.A.)

EARTH SCIENCES

Geology and Hydrology

Refer also to abstracts 45195, 45421, and 45566.

45396 (COO–689–120) CORRELATION AND CHRONOLOGY OF ORE DEPOSITS AND VOLCANIC ROCKS. Annual Progress Report. Damon, Paul E. (Arizona Univ., Tucson. Lab. of Isotope Geochemistry). July 1969. Contract AT(11-1)-689. 141p. Dep. CFSTI.

Refinements in experimental equipment and techniques for performing argon analyses on rock samples are described. Methods for flame photometric potassium analysis and rubidium and strontium determinations by mass spectrometry and x-ray fluorescence analysis were unchanged. Gamma spectrometry was used to measure radiation emitted from geologic and reactor irradiated samples. Studies continued to determine: the low-temperature loss of ^{40}Ar in potash feldspars; strontium diffusion in feldspar; $^{87}Sr/^{86}Sr$ ratios in Arizona volcanic rocks; geologic history of the Chiricahua Mts.; K–Ar dating information on ores from the Tintic District, Santa Catalina Mts., Tortalita Mts., the Arizona Basin and Range Province, and a sample of "Older Tuff" material from South Tanzania, Africa. Trace element and chemical-petrographic studies were continued with emphasis on the behavior of Mo, Ti, and W in the porphyry copper environment. The chemical compositions of numerous samples of volcanic rocks of various geographical origins are tabulated. (L.C.L)

45397 (NVO–40(Rev.2), pp 51-9) GEOLOGIC CONSIDERATIONS. Stead, Frank W. (Geological Survey, Denver, Colo.).

The geologic and hydrologic information needed to evaluate specific safety criteria established by the USAEC are reviewed. As demonstrated by the examples given, the geologic and hydrologic environment of each proposed underground nuclear explosion must be determined on an individual basis from at-depth information. The limitations on obtaining adequate geologic information at depths such as 1 or 2 miles are primarily economic rather than technical. Given sufficient funds for deep-hole exploration, the environment of any proposed site of an underground nuclear explosion can be determined within a predetermined accuracy. (L.C.L.)

45398 (NVO–40(Rev.2), pp 61-7) HYDROLOGIC CONSIDERATIONS. West, Samuel W. (Geological Survey, Denver, Colo.).

The US Geological Survey conducts hydrologic studies in support of underground nuclear tests to provide data on the occurrence, quality, and quantity of ground and surface waters which might be affected by the testing. In addition to supplying safety information to assure the public that radioactive contamination of water resources is restricted to a known area and that adequate water supplies will be available following the nuclear tests, these studies provide hydraulic engineering information useful to the construction phase of the nuclear test program. Methods of collecting and evaluating hydrologic information at Nevada test sites are discussed. (L.C.L.)

45399 (NVO–40(Rev.2), pp 69-82) PREDICTION OF RADIONUCLIDE MIGRATION IN GROUND WATER. Fenske, Paul R. (Isotopes, Inc., Palo Alto, Calif.).

A method for predicting the hypothetical contamination of ground water due to the migration of underground explosion-produced radioisotopes is described. The basic data required include radioisotope production, explosion zone parameters that affect the sorption, dispersion, and radioactive decay of the radioisotopes, and the velocity and direction of ground water flow through the explosion zone. Simple predictions are calculated to illustrate the method. (L.C.L.)

45400 (PINSTECH/HP–9) RADIOISOTOPES AS TRACERS IN WATER RESOURCE INVESTIGATIONS AND SANITARY ENGINEERING PROBLEMS. Shaikh, Unis (Pakistan Inst. of Nuclear Science and Technology, Islamabad. Health Physics Div.). 1969. 69p. Dep. CFSTI (U. S. Sales Only).

Some major applications of radiotracer techniques employed in water resource investigations and sanitary engineering problems are reviewed with discussions of the following topics: measurement of the velocity of longitudinal mixing due to water movement in pipes and sewers; detention and short-circuiting in sedimentation and contact basins; flow patterns in tanks: analytical techniques for water and waste water examination; floc penetration in porous media; underground movement of pollution and time of flow, purification of streams; and uses of radioisotopes in groundwater hydrology and surface waters. A brief description on radioactive tracer instrumentation and counting statistics is included. (auth)

45401 THE STABLE ISOTOPE COMPOSITION OF MINERAL WATERS IN THE JORDAN RIFT VALLEY, ISRAEL. Gat, Joel R.; Mazor, E.; Tzur, Y. (Weizmann Inst. of Science, Rehovoth, Israel). J. Hydrol., 7: 334-52(Mar. 1969).

The ^{18}O and ^{2}H contents of water from 66 sources in the Rift Valley were tabulated. These data were taken from 4 laboratories which have analyzed samples from this region. The reproducibility claimed for these analysis was in all cases better than $\sigma(\delta^{18}O) = \pm 0.2‰$ for ^{18}O and $\sigma(\delta_D) = \pm 1.5‰$ for ^{2}H, except for some of the early ^{2}H measurements. Results of these studies of the stable isotopic composition (^{18}O and ^{2}H) of the mineral water sources in the Jordan Rift Valley indicated that these sources evolved through a 2-stage mixing process. It was postulated that, sometime in the past, waters of a slightly evaporated seawater lake had mixed with the prevailing groundwaters, to form different fossil brine pockets along the Rift Valley's floor. These brines mix nowadays with present-day local ground waters and in some cases also with lake waters from adjacent Lake Tiberias or the Dead Sea. There was no evidence of marked changes in the isotopic content of the water concerned by exchange with rocks or by other fractionating processes. (BBB)

45402 LANTHANIDES IN THE NORTON COUNTY ACHONDRITE. Masuda, Akimasa (Goddard Space Flight Center, Greenbelt, Md.). Geochem. J. (Nagoya), 2: 111-35(Nov. 1968).

Lanthanide concentrations in 13 fractions of the Norton County achondrite have been determined by a mass spectrometric isotope dilution method. The distribution of lanthanides was quite different between enstatite single crystal and polycrystalline material. This difference was interpreted in terms of different formation processes. It is thought that in the growth of single crystals, individual ions were placed one by one to build a strictly defined lattice structure, whereas the polycrystalline material was produced by the transitional formation of amorphous phases or phases of low crystallinity resulting from spontaneous cohesion of neighboring ions in the melt. The lanthanide patterns for single crystal fractions were similar to each other, but there was some variation between them in the fine structure of the patterns. This can be interpreted as a reflection of the fact that the partition of lanthanides into single enstatite crystals was more or less sensitive to rather subtle differences in the conditions of crystal growth. The genesis of Shalka, Johnstown (both hypersthene achondrites) and eucritic achondrites can be interpreted in terms of the precipitation of single crystals only. A great difference in partition coefficient between single crystals and polycrystalline material system appeared to be of much petrological significance, because it is thought that the difference can also bring about a great difference in efficiency of enrichment of calcium in remnant liquid. Irregular behavior of Ce, Eu, and Yb in a few single-crystal fractions was ascertained by independently processed redeterminations. The irregularities may be ascribed to single crystals favoring higher valence state of these elements relative to the melt. It is suggested that lanthanum might have been a little depleted relative to the other lanthanides in the initial melt that produced Norton County. (NSA of Japan)

45403 RATIO OF CHLORIDE ION CONCENTRATION TO RADON IN MINERAL WATERS USED AS HYDRORADIOCHEMICAL TRACER. Rymaszewska, Maria (Univ., Warsaw). Acta Geophys. Pol., 17: 197-202(1969). (In Polish).

A dependence between the concentration of chloride ions and the radioactivity of radon dissolved in mineral waters has been observed in various types of Polish radioactive waters and evaluated. Large quantities of radon have been observed only in the mineral waters with a low concentration of chloride ions. (auth)

45404 THE ALTITUDE EFFECT ON THE ISOTOPIC COMPOSITION OF PRECIPITATION AND GLACIER ICE IN THE ALPS. Ambach, W. (Innsbruck Univ.); Eisner, H.; Dansgaard, W.; Moeller, J. Tellus, 20: 595-600(1968).

Rain samples were collected simultaneously from 3 stations in the Alps (altitude difference 1680 m). They showed that the evaporation from falling drops caused an isotopic altitude effect of −0.2 per ml per 100 m. Despite the lack of altitude effect in Alpine snow fall, the summer melting and the wind erosion cause distinct isotopic variations in the net accumulated material on Kesselwandferner. These variations are reflected in the ice in the ablation zone, and they may be used for studying glacier flow patterns. (Sweden)

45405 SOME COSMIC RAY PRODUCED RADIOACTIVITIES IN THE COUNTY ACHONDRITE AND THE PEACE RIVER CHONDRITE. Matsuda, Hideki (Tokyo Univ.). Geochem. J. (Nagoya), 2: 167-74(Nov. 1968).

Activities of two cosmic-ray produced radionuclides, ^{10}Be and ^{26}Al, were determined for the Norton County achondrite. ^{10}Be, ^{22}Na, ^{26}Al, ^{44}Ti, ^{53}Mn, and ^{60}Co were determined for the Peace River chondrite. Except for ^{10}Be and ^{53}Mn, these activities were measured employing a low-level β-γ coincidence method. Combining these data with those reported for stable rare gases, the radiation age of Norton County achondrite was calculated to be $(120 \pm 20) \times 10^6$ yr which is significantly lower than previous estimations by a factor ranging from 2 to 5. The results for Peace River were compared with other experiments that appeared in the literature, and the shielding effects are discussed. (auth) (NSA of Japan)

45406 APPLICATION OF NUCLEAR TECHNIQUES IN HYDROLOGY IN THE HUNGARIAN PEOPLE'S REPUBLIC. Erdelyszky, Zsigmond (Vizgazdalkodasi Tudomanyos Kutato Intezet, Budapest). Atomtech. Tajek., 11: 647-52(Dec. 1968). (In Hungarian).

Several measurements have been made since 1959 regarding ground water flow to investigate the utilizable ground water reserves and the eroding conditions on the Small Hungarian Plain and on the territory between the Rivers Danube and Tisza. The determination of the deuterium, tritium, and ^{18}O contents in surface and underground waters of the Hungarian territory has been started. Radioisotopic investigations were carried out on the shifting of silt and sand in the Lake Balaten, using activated glass-grist, grain-size, specific weight, and chrome-content, which was similar to those of the deposits in the lake-bed. At the Danube-reach at Dunaremete the movement of rolled bed-load was examined by an isotopic tracer method using ^{65}Zn, ^{181}Hf, ^{95}Zr, and ^{124}Sb. On the basis of the data obtained a new erosion law was determined regarding movement. It was concluded that the speed of movement is not decisively influenced by grain size. (auth)

45407 PREDICTING THE MOVEMENT OF A RADIONUCLIDE THROUGH SOIL. Plato, Phillip Alexander. Iowa City, Iowa, Iowa State Univ., 1968. 154p.

Thesis.

A method for predicting the rate of movement of a simple waste through soil was developed. The waste material selected was strontium, an important constituent of many radioactive liquid wastes because of its chemical similarity to calcium which is an element that is used in the synthesis of teeth and bones. Soil columns were used in which flow moved in one direction, and a soil tank was used in which flow moved in the horizontal and vertical directions away from a modeled waste seepage pit. In an attempt to obtain more reproducible results in examining the mechanisms responsible for the movement of strontium through soil, a cation exchange resin was used to simulate the soil. Stable calcium was substituted for radiostrontium which resulted in an analytical technique for measuring cationic concentrations which was faster than determining the concentrations radiochemically. An equation, which accurately predicted the movement of calcium through the ion exchange resin was developed, and incorporated the flow rate through the resin, the concentration of the influent solution, and the resin bed depth. However, the equation did not prove to be applicable in predicting the movement of cations through soil due to the relatively large time required for the cations to diffuse into the soil particles. An empirical equation was developed which tended to describe the results obtained when calcium solutions were passed through soil columns. A design of a field study based on the empirical equation was suggested. (TSS) (Disser. Abstr.)

45408 TREATMENT OF POLLUTED WATERS WITH RADIATION. Sunada, Tsuyoshi (Osaka Prefectural Radiation Center, Sakai, Japan). Soda To Enso (Tokyo), 20: 123-34(Apr. 1969). (In Japanese).

Studies were made on the radiation treatment of polluted river waters that have been polluted in recent years by industrial wastes and agricultural chemicals. Phenol from industrial wastes gave an offensive odor but when treated with radiation the odor decreased. Radiation treatment was more effective when the initial concentration of phenol in polluted water was low. Therefore, it was desirable to dilute it as much as possible before irradiation. Irradiation at 10,000 Rad reduced 2 ppM of ABS (a surface activator) to 0.5 ppM, a permitted value. For parathion, an agricultural chemical, 10,000 Rads destroyed 97% and 100,000 Rads destroyed 99% of 1 ppM. For phenylmercuric acetate, an agricultural chemical, 10,000 and 100,000 Rads destroyed 30 and 80%, respectively of PMA, methylmercuric chloride was dissociated by irradiation, but its derivative still remained in the water. The economics, advantages, and disadvantages for the radiation treatment of polluted waters are described. (NSA of Japan)

Meteorology

Refer also to abstracts 45453, 46009, 46010, and 46295.

45409 (NVO-40(Rev.2), pp 251-60) METEOROLOGY AND NUCLEAR DETONATION SAFETY. PART A. ATMOSPHERIC TRANSPORT OF RADIOACTIVE EFFLUENTS. Allen, Phillip W. (Environmental Science Services Administration, Las Vegas, Nev. Air Resources Lab.).

Airborne radioactive materials are transported and dispersed by atmospheric motions, knowledge of which aids in scheduling nuclear experiments and planning safety actions in such a way as to minimize any radiological hazards. Properties of the atmosphere that influence safety decisions include wind, trajectories, thermal and mechanical turbulence, and precipitation. These and other atmospheric parameters are measured in an appropriately scaled observational network and changes are predicted using conventional numerical techniques and techniques that have been developed for the local area. Some of the more important recent developments in knowledge of air motion and in prediction techniques are described. There are limitations on the accuracy of predictions, and a review is given on the effects of these limitations on nuclear test safety. (auth)

45410 (NVO-40(Rev.2), pp 261-70) METEOROLOGY AND NUCLEAR DETONATION SAFETY. PART B. LOCAL FALLOUT AND DIFFUSION OF RADIOACTIVE MATERIAL. Mueller, Harold F. (Environmental Science Service Administration, Las Vegas, Nev. Air Resources Lab.).

The detonation of a nuclear device requires an appraisal of potential radiological consequences resulting from the expected or accidental release of radioactive material to the atmosphere. Radioactivity production, the manner by which radioactive material may be released to the atmosphere, and source term assumptions for several types of nuclear detonations are briefly described. The use of observed radiological data is discussed. Currently employed prediction techniques are presented and an evaluation of predictive capability is demonstrated for cases where comprehensive radiological data are available. (auth)

45411 A COMPARISON OF TRITIUM AND ^{90}Sr FALLOUT IN THE SOUTHERN HEMISPHERE. Taylor, C. B. (Univ., Heidelberg). Tellus, 20: 559-76(1968).

The histories of tritium and ^{90}Sr fallout in the Southern Hemisphere were compared from the data available to June 1966. The seasonal variation pattern (July to June) for tritium in mid-latitude oceanic rainwaters was fairly closely reproduced from year to year, and peaked in late winter to spring. The peak coincided with the absence of the temperature inversion at the polar tropopause, suggesting that the stratosphere-troposphere exchange of the bulk of Southern Hemisphere tritium fallout took place over the polar regions. For ^{90}Sr in mid-latitude rainwaters, the seasonal variation pattern was not so closely reproduced from year to year, but showed a broad summer maximum and winter minimum. It appeared that the bulk of the bomb particulate products mixed southward within the lower stratosphere and entered troposphere at mid-latitudes, the seasonal fallout variation was similar to that found for the Northern Hemisphere, but 6 months out of phase. Consideration of the balance of tritium in the troposphere led to a relation which allowed a seasonal variation pattern for the stratosphere-troposphere exchange of tritium to be deduced from the rainwater concentrations. Stratospheric measurements of bomb particulate products were taken into account in an assessment of ^{90}Sr southward mixing paths. An attempt was also made to deduce the origin and possible southward mixing paths for thermonuclear tritium appearing in the Southern Hemisphere. The history of the tritium ^{90}Sr annual (July to June) mean activity ratio is quite erratic, and it is not constant over the entire Southern Hemisphere at any one time. (auth) (Sweden)

45412 ATTEMPT TO TRACE THE MONSOON FLOW USING NATURAL RADON. Rama (Tata Inst. of Fundamental Research, Bombay). Indian J. Meteorol. Geophys., 19: 167-70(Sept. 1969).

Measurements of radon concentration in air over the Arabian Sea and the Indian Ocean are reported. The results enable an identification of southeast trades and of continental air in the monsoon current to be made. (auth)

45413 DEPOSITION OF RADIOACTIVE FALLOUT BY THE 7TH COMMUNIST CHINESE NUCLEAR TEST. Takizawa, Yukio (Niigata Univ., Japan). Nippon Koshu Eisei Zasshi, 16: 483-5 (Apr. 1969). (In Japanese).

Reportedly, Communist China carried out its 7th nuclear test in the atmosphere on December 24, 1967. The test was on a small scale, about 20 kilo-tons. The deposition phenomena of radioactive fallout were observed concerning strongly radioactive particles, precipitation, air-borne dusts, etc. The state of deposition of the

strongly radioactive particles was similar to that in the 3rd nuclear test; the deposition after the test was rapid, and the amount of deposition was not large. The specific radioactivity of the particles was low, compared with that in the third test. The observation of strongly radioactive particles by an optical microscope showed that, in general, the particle size was about 14 μ, spherical shape, and the color was yellowish brown. The radioactivities in the precipitation were not especially high, compared with the normal value before the test; rather, they tended to be high two weeks later. No abnormalities were observed in the air-borne dusts. (NSA of Japan)

45414 ON THE RESULTS OF SURVEY OF THE RADIOACTIVITIES FROM THE 8TH COMMUNIST CHINESE NUCLEAR TEST. Genshiryoku Iinkai Geppo, 14: No. 2, 13-14(Feb. 1969). (In Japanese).

Communist China carried out its 8th nuclear test on December 27, 1968. Immediate radioactivity surveys from the 27th to the 31st of December, showed that no special abnormalities in radioactivities occurred and no strongly radioactive particles existed. However, high-altitude airborne radioactive dusts of 400 to 750 pCi/m^3 were detected above the area between Matsushima and Hachinohe on the 28th. It was thus indicated that there had been no direct effects of radioactivities from the 8th nuclear test in Japan. Data from the radioactivity surveys, carried out in Japan, are tabulated, including radioactivities in precipitation, high-altitude airborne dusts, near-earth-surface airborne dusts, falling dusts, and milk. (NSA of Japan)

45415 AMOUNT OF DUST PRECIPITATED AND ITS INFLUENCE ON FALLOUT ACTIVITY LEVEL. Csupka, St. (Bezirkshygiene-Institut, Bratislava). Kernenergie, 12: 136-8(Apr. 1969). (In German).

The fallout was investigated during 1962 to 1966. Some meteorological factors were simultaneously measured. Observing the fallout for several years enabled a relationship between the amount of dust precipitated and radioactivity to be established. For the station, for which the higher amount of dust was found, an elevated fallout total beta activity due to both ^{90}Sr and ^{137}Cs has also been stated. These relationships manifested themselves in the correlation coefficients, which showed higher values for the measuring stations with the higher dust precipitated than for those with the lower amount of dust. (auth)

45416 ^{22}Na DEPOSITION BY RAIN IN THE YEAR 1968. Mueh, H.; Sittkus, A. (Max-Planck-Institut fuer Kernphysik, heidelberg). Naturwissenschaften, 56: 211(Apr. 1969). (In German).

The ^{22}Na deposition in rain in Freiburg was measured from January through November of 1968. The monthly depositions are tabulated. The total deposition through November was 7.5×10^7 atoms/m^2. The values, compared with those of Heidelberg from 1963 to 1966 showed an increase in the ^{22}Na, attributed to the Chinese nuclear tests. (J.S.R.)

45417 EXTERNAL RADIATION ON BIKINI ATOLL. Bennett, B. G.; Beck, H. L. (Atomic Energy Commission, New York). Nature (London), 223: 925-8(Aug. 30, 1969).

In a survey made in May 1967 a large number of radionuclides were found contributing to the residual radiation fields, leading to wide variations in external exposure rates. The survey showed that most of the radiation remaining after the explosion was due to ^{137}Cs, and that some 15% of the activity on some islands was due to ^{60}Co produced by the activation of ^{59}Co and ^{60}Ni in the steel barges used for weapon platforms. The survey also showed the pattern of radioactive isotopes such as ^{152}Eu, detected infrequently after previous explosions. (UK)

Mineralogy and Exploration

Refer also to abstract 45190.

45418 (CONF-690815-1) APPLICATION OF AERIAL GAMMA RADIATION SPECTROMETRY IN AUSTRALIAN MINERAL EXPLORATION. Geology Paper No. 3. Lawrence, M. J. (New South Wales Univ., Kensington (Australia). School of Mining Engineering). Mar. 19, 1969. 33p. Dep. CFSTI (U. S. Sales Only).

From Conference of the Australian Institute of Mining and Metallurgy, Sydney, Australia.

The practice and experience of Geophysical Resources Development Co. (GRD) with the technique of airborne gamma spectrometry are outlined and its particular application to uranium search is discussed. The basic theoretical principles of natural radioactivity are reviewed. A brief history of radiation detection instrumentation is presented, together with the theory underlying its design and operation. The primary consideration in the selection of survey system parameters is the variation of gamma flux with height. Other factors are terrain clearance, aircraft speed, instrument time constant, and line spacing. Survey aircraft requirements are exceptional performance and dependability, high maneuverability, low stall and high cruise speeds, sufficient power for instrument supply, room for electronic installation, low initial and operating costs, and adaptability. The GRD search pack consists of a high resolution ASQ010 Fluxgate magnetometer and either an Exploranium DGRS-1000 or Nuclear Enterprises Mark XII Spectrometer, recording on 10 in. Moseley 7100 B chart recorders. A continuously recording TRN-70 Bonzer Radar Altimeter and a 35 mm flight path recording camera assist in data reduction. Changeover to Doppler from gyro-compass navigation will enhance accuracy of survey data plotting. Several profiles recorded in a South Australian test are presented to illustrate the effects of varying certain parameters on the recorded radiation. (Australia)

45419 THE SITUATION ON THE URANIUM MARKET AND THE NUCLEAR FUEL SUPPLY FOR EUROPE. Guenzel, H.; Knoerr, B. Metall, 23: 617-19(June 1969). (In German).

The growth of the fuel needs of Europe up to 1980 is estimated. The development of uranium industries in Canada, Africa, and Australia is outlined. The insignificant European occurrences are indicated. (J.S.R.)

45420 URANIUM RESERVES AND PROGRESS IN EXPLORATION AND DEVELOPMENT. Butler, Arthur P. Jr. Geological Survey Circular 547. Washington, D. C., Geological Survey, 1967. 10p.

Uranium resources and exploration are discussed in terms of the demand for U, the quantity of reserves as projected to the end of the AEC buying program in 1970, and the outlook for discovering more reserves based on the general characteristics and distribution of known reserves. It was concluded that U reserves available by the end of 1970 will be adequate to meet the fuel needs of all power-producing reactors, either existant or ordered by May 1970, and that improved U technology will provide for the fueling of future reactors. (L.C.L.)

Oceanography

45421 (ORO-3622-5) ABSOLUTE DATING OF OCEAN SEDIMENTS BY USE OF ^{230}Th/^{231}Pa RATIO AND GEOCHEMICAL STUDIES OF LIMITING BOUNDARY CONDITIONS WITH SPECIAL ATTENTION TO EXOTIC ENVIRONMENTS. Annual Progress Report. Rona, Elizabeth (Miami Univ., Fla. Inst. of Marine Science). Aug. 1969. Contract AT(40-1)-3622. 14p. Dep. CFSTI.

The results of continued oceanographic research which involves the absolute dating by radioactive methods of several deep ocean cores from the Caribbean and the radiochemical analyses of cores from anoxic basins, specifically from Powell Lake, B. C. and from the Cariaco Trench, are presented. Both ^{14}C and ^{230}Th/^{231}Pa dating methods were used—the former for ages up to 40,000 years, and the latter for ages up to 150,000 years. Using these methods, it was found that the most consistent results were from deep-sea cores taken from the Caribbean Sea. (L.C.L.)

45422 PLUTONIUM CONTENT IN THE WESTERN NORTH PACIFIC WATERS. Miyake, Yasuo; Sugimura, Yukio (Meteorological Research Inst., Tokyo). Pap. Meteorol. Geophys. (Tokyo). 19: 481-5(Oct. 1968).

The content of plutonium in seawater collected in the western North Pacific off Japan was determined. Plutonium was analyzed by the α spectrometric method after isolating it from a large volume of seawater by hydroxide coprecipitation and an anion exchanger. The plutonium content in seawater ranged from 1.8 to 22.6×10^{-15} g/l in the surface waters. Even in the intermediate or deep waters, comparatively high concentration of plutonium was determined. The ratio of ^{238}Pu/^{239}Pu ranged from 7 to 28%. (NSA of Japan)

Seismology

Refer also to abstracts 45579 and 45582.

45423 (NVO-40(Rev.2), pp 99-172) GROUND MOTION. Davis, Lawrence L. (Environmental Research Corp., Alexandria, Va.).

For 7 years the Environmental Research Corporation has been responsible for providing predictions of ground motions from underground nuclear explosions and of their effects on subsurface facilities. A general discussion of the prediction methods used is

followed by a technical discussion of calculations based on data for particular events. The principal parameters required for these predictions include knowledge about the explosion, rock structure in the immediate vicinity of the detonation, and geology of the region through which the seismic wave is propagated. Following each explosion, recorded seismic data are processed and analyzed to evaluate the accuracy of the prediction methods, and to refine the methods for future tests. Comparisons of predicted and measured seismic conditions indicate a high degree of accuracy associated with the ground motion predictions, especially from events detonated at the Nevada Test Site. (L.C.L.)

45424 (NVO-40(Rev.2), pp 173-226) STRUCTURAL RESPONSE TO NUCLEAR INDUCED GROUND MOTION. Blume, John A. (Blume (John A.) and Associates Research Div., San Francisco, Calif.).

Structural response to ground motion induced by underground nuclear explosions is discussed in general and specific terms. The general discussion covers the fundamentals of structural response, the complexities of response prediction, treatment of data, techniques and types of predictions, and the significance of responses in terms of structural damage. The technical, or specific, discussions illustrate how structural response calculations are made for a given type of structure and methods for estimating damage. It was concluded that it is possible to predict structural behavior with reasonable accuracy provided the real structural properties of a building are known and that ground motions have been predicted accurately. Data from the Nevada Test Site and central Nevada area ground motion measurements are sufficient to ensure the safety of structures in that area. More conservative safety measures are recommended for less well-known underground nuclear explosion sites. (L.C.L.)

45425 (NVO-40(Rev.2), pp 227-37) EARTHQUAKES AND AFTERSHOCKS RELATED TO NUCLEAR DETONATIONS. Weart, Wendell (Sandia Labs., Albuquerque, N. Mex.).

The present state of knowledge of the relationship between nuclear detonations and seismic and earthquake events is summarized with particular reference to data from two of the largest underground tests, Benham and Boxcar. To date these studies show that: all earthquake and aftershock activity magnitudes have been much smaller than the magnitude of the responsible detonation itself; all seismicity has been confined to the test site, usually within 12 km; no permanent strain due to nuclear detonations has been observed beyond 30 km; and further studies are necessary to ensure the safety of regions near higher yield tests. (L.C.L.)

ENGINEERING

Nuclear Explosions

Refer also to abstracts 45397–45399, 45409, 45410, 45423–45425, 45436, 45488, 45582, 45682, 45736, and 46153.

45426 (NVO–40(Rev.2)) TECHNICAL DISCUSSIONS OF OFF-SITE SAFETY PROGRAMS FOR UNDERGROUND NUCLEAR DETONATIONS. (Reynolds Electrical and Engineering Co., Inc., Mercury, Nev.). May 1969. 311p. Dep. CFSTI.

Discussions of offsite safety programs for assuring that underground nuclear detonations are free from danger or risk, are presented in 15 chapters. A separate abstract was prepared for each of 14 chapters. In addition, a separate abstract was prepared for each of Parts A and B of Chapter 13. (R.C.K.)

For abstracts of individual chapters see: 45397–45399, 45409, 45410, 45423–45425, 45427–45431, 45582, 45682, and 45736.

45427 (NVO–40(Rev.2), pp 1) SAFETY RESPONSIBILITIES OF NEVADA OPERATIONS OFFICE. Miller, Robert E. (Nevada Operations Office (AEC), Las Vegas).

The Nevada Operations Office of the AEC has the prime responsibility for the execution and safety of all underground nuclear detonations carried out by the US government, and meets this responsibility with two safety programs. The first prepares, provides, and evaluates all safety measures taken at the time of a detonation, and the second involves long range studies of detonation event-related phenomena. (L.C.L.)

45428 (NVO–40(Rev.2), pp 3-7) HISTORY OF U. S. NUCLEAR TEST PUBLIC SAFETY PROGRAMS. Vermillion, Henry G. (Nevada Operations Office (AEC), Las Vegas).

The history of US nuclear test public safety programs from the time of the first test in New Mexico in 1945 to the present is reviewed with emphasis on programs for evaluating fallout hazards, air blast effects, radiation monitoring, seismic and ground motion effects, and hydrologic effects. Since July 1962 all nuclear testing in the US has been underground. The hazards from atmospheric tests prior to that date are discussed, and present capabilities for conducting fully-contained underground tests are summarized. (L.C.L.)

45429 (NVO–40(Rev.2), pp 9-12) REVIEWS TO INSURE SAFETY OF NUCLEAR OPERATIONS. Thalgott, Robert H. (Nevada Operations Office (AEC), Las Vegas).

The system of reviews used by the Nevada Operations Office to ensure the safety of nuclear detonations is outlined, and charts indicating the chronological steps used in the safety reviews are presented. The safety of each nuclear test depends first on the ability to accurately predict the hazards of a given explosion, and second, on devising techniques to assure containment of radioactivity during and following each test. Progress in achieving these safety goals is noted. (L.C.L.)

45430 (NVO–40(Rev.2), pp 13-50) PHENOMENOLOGY AND CONTAINMENT OF UNDERGROUND NUCLEAR EXPLOSIONS. Germain, Lawrence S.; Kahn, J. S. (California Univ., Livermore. Lawrence Radiation Lab.).

The phenomenology and containment of underground nuclear explosions were examined by studying: first, historical data on detonation phenomena and radioactivity release from routine underground nuclear explosions; second, calculations of early-time (i.e., first few tenths of a second following detonation) interactions between a nuclear explosion and its surrounding media; third, calculation and measurement of late-time (post early-time) phenomena; and, fourth, the effects of geological conditions on cavity formation and containment. A considerable amount of calculated and empirical data on cavity growth, ground motion, rock stresses, particle velocities, ejection mechanisms, radioactivity in chimneys, etc. are presented in graphic form. (L.C.L.)

45431 (NVO–40(Rev.2), pp 239-49) MINE AND WELL INSPECTION PROGRAM. Russell, Paul L. (Bureau of Mines, Denver, Colo. Denver Mining Research Center).

The Mine and Well Inspection Program conducted for the AEC by the U. S. Bureau of Mines, was established to provide a system of controls for assessing and evaluating any damage to a mine or gas or oil well alleged to be the result of an underground nuclear explosion. The mine and well examination and safety surveys are conducted before a nuclear event to document preshot conditions and to make protective recommendations where necessary, and after the nuclear event to record any physical changes and to assess the damages. All phases of the program are described briefly and include surveys of the mines and their structures, radiation conditions, seismic effects evaluations, and recording of geologic and hydrologic conditions. The program protects both Government and industry and has been successful due to cooperation from both. (L.C.L.)

45432 (RM–6033) TRANSPORT CALCULATIONS PERTINENT TO SATELLITE DETECTION OF X RAYS FROM NEAR EARTH NUCLEAR EXPLOSIONS. Hubbard, Harmon W. (RAND Corp., Santa Monica, Calif.). July 1969. 33p.

A study of nuclear explosion detection by satellite instruments is continuing. In order to examine the effects of scattering of x rays by the atmosphere before detection at a satellite, Monte Carlo calculations have been made for point monoenergetic sources of 10, 30, and 100 keV at altitudes from 30 to 150 km. Results are given for the ratio of scattered to vacuum energy deposition as a function of satellite observation angle, and for the energy spectra observed at fixed angles of observation. (auth)

45433 (UCRL–50658) PLOWSHARE STREAMLINED OPERATIONAL SYSTEM. Nordyke, M. D.; Lundberg, A. W.; Ragsdale, W. F. (California Univ., Livermore. Lawrence Radiation Lab.). June 26, 1969. 13p. Dep. CFSTI.

In an effort to reduce the cost and time required to field Plowshare underground-engineering experiments and to improve the reliability of the nuclear explosives, a program to develop a "streamlined" operational or fielding system was recently initiated at the Lawrence Radiation Laboratory, Livermore. The overall concept used to develop this integrated system is outlined and several key elements are described. (auth)

45434 (UCRL–71867) PERSISTENCE OF RADIONUCLIDES AT SITES OF NUCLEAR DETONATIONS. Koranda, John J.; Martin, John R. (California Univ., Livermore. Lawrence Radiation Lab.). July 15, 1969. 49p. (CONF-690303–3). Dep. CFSTI.

From Symposium on the Biological Implications of the Nuclear Age, Livermore, Calif.

A study of the persistence of radioisotopes at nuclear detonation sites is extremely important for evaluating future peaceful engineering uses of nuclear explosions such as the excavation of canals and harbors. Information on the distribution of radioisotopes at test detonation sites (Pacific Proving Ground and Nevada Test Site), where earth has been moved to create craters or trenches, was studied and the uptake of certain radioisotopes by plants and animals in the areas was examined. Sedan Event data on tritium concentrations in crater fallback, crater soil water, tissue water of plants growing on ejecta, and kangaroo rats living in the Sedan area are presented. Five years after the shot, tritium was found to be the most abundant radioisotope in ejecta or in any biological system in the area. (L.C.L.)

45435 PEACEFUL USE OF NUCLEAR EXPLOSIVES. SOME ECONOMIC ASPECTS. Brooks, David B.; Krutilla, John V. Washington, D. C., Resources for the Future, Inc., 1969. 52p. $1.50. The Johns Hopkins Press, Baltimore.

Peaceful uses of underground nuclear explosions, i.e., earth moving and gas and petroleum stimulation and recovery, are examined first, in cost terms related to engineering considerations such as explosive design and production, emplacement costs, safety requirements, and comparisons with conventional rock fracturing methods, and second, in terms of the costs of particular applications such as fracturing for natural gas stimulation, creating underground storage areas, tunnel blasting, and canal excavation. It was concluded that Plowshare experience in terms of the economic evaluation of proposed applications must be analyzed in the case of relatively small nuclear explosions, such as Ketch and Gasbuggy, by comparison with conventional methods for accomplishing the same results, whereas the really large detonations such as are necessary for canal excavation may be economically feasible, but impose political and safety problems of a magnitude likely to cancel the economic advantages. (L.C.L.)

Facilities and Equipment

Refer also to abstracts 45183, 45431, 45457, 45483, 45484, 45486, 45487, 45575, 45719, 45978, 45983, 46002, 46005, 46039, 46120, and 46434.

45436 (AD–687366) TEST DEVICES BLAST LOAD GENERATOR FACILITY. Final Report. Huff, William L. (Army Engineer Waterways Experiment Station, Vicksburg, Miss.). Apr. 1969. 35p. (AEWES-N–69-1). CFSTI.

The various test devices of the Blast Load Generator Facility and their capabilities are described. The Large Blast Load Generator is capable of testing models of underground protective structures at pressure up to 500 psi dynamically and 1000 psi statically. The Small Blast Load Generator can be used to test small models at static pressures up to 2000 psi and dynamic pressures up to 250 psi. Higher static and dynamic pressures can be obtained using the 15,000-psi static loader and 1500-psi detonable-gas shock tube, respectively. For determination of the static and dynamic properties of materials, the 200- and 500-kip loaders are available. (auth) (USGRDR)

45437 (ANL–7520(Pt.1), pp 335-44) TESTS OF A TUBE-IN-TUBE SODIUM-HEATED STEAM GENERATOR. Buescher, E.; Jansing, W.; Knuth, H.; Mausbeck, H. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)).

A 5 MW test facility was developed for use in the KNK Reactor experiment. The tube-in-tube steam generator design allowed a variety of measurements to be made. The hydrodynamic characteristics, in particular on the water–steam side, were investigated by pressure measurements, in part by means of nozzles at several points in the tube. By this means pressure drop in different parts of the tube system could be measured: pressure drop across the entrance orifice and pressure drop across the preheating zone. The thermodynamic behavior was measured by means of 26 thermocouples T at the outer wall of the sodium tube. Additional temperature measurements on the water–steam side were made at the above-mentioned nozzles. Finally, the nozzles served for a survey of the corrosion behavior on the water–steam side. Continuous hydrogen measurements and sample iron and oxygen measurements were taken. Additional bulk pressure, flow, and temperature readings at the sodium and water–steam sides were also made. (J.C.W.)

45438 (ANL–7520(Pt.1), pp 506-14) LIQUID SODIUM TECHNOLOGY DEVELOPMENT. II. SODIUM LOOP COMPONENTS AND RELATED TECHNIQUES. Furukawa, Kazuo; Yamamoto, Ken; Nihei, Isao; Kamei, Mitsuru (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment).

The Mother and Daughter Test Loop System was extended by adding many daughter loops. At present there are 11 daughter test loops that include: mass transfer test loops No. 1, 2, and 3; impurity-behavior test loop; heat-transfer test loop; flowmeter-calibration bypass; fuel-assembly-assurance test loop; fuel-assembly flow-test section; pump test loop; sodium-sampling and vacuum distillation bypass; and valve-test bypass. Results obtained in the development of electromagnetic and canned-motor pumps, valves, nonwelded pipe joints, air cooling tubes, flowmeters, cold traps, hydrogen separators, vacuum distillators, fire extinguishers, thermal insulators, and heaters are described. (J.C.W.)

45439 (ANL–7535, pp 131-3) WALL SHIELDING STUDIES ON THE JANUS HIGH FLUX ROOM. Williamson, Frank S.; Jordan, Donn L. (Argonne National Lab., Ill.).

Measurements on test sections of the wall treatment proposed for the JANUS High Flux Room support the calculations made by D. H. Shaftman and A. E. Mcarthy, while indicating that neutron activation occurs in the lead layer of this treatment. The gamma dose rate produced at the activated test section is small enough to be acceptable in spite of this additional contribution. Further sampling and testing of the lead bricks to be used is being carried out in order to ensure that these measurements are representative. (auth)

45440 (ANL–7535, pp 133-4) THE EFFECT OF SHUTTER EXTENSION ON NEUTRON DOSE-EQUIVALENT RATES IN THE JANUS HIGH FLUX EXPOSURE ROOM. Schumacher, Martin C.; Ryba, Eugene W. (Argonne National Lab., Ill.).

Simple extension of the present shutter on the JANUS Reactor yields a tenfold reduction in dose-equivalent rate, implying that 90% of the present exposure results from neutrons that enter the room over the top of the shutter. The proposed new shutter will effect a shielding improvement by a factor of 100, and more likely 400, over the present arrangement. The dose-equivalent rate from leakage at room center will be reduced to less than 100 mRem/hr, and probably to less than 25 mRem/hr. Allowable room occupancy will be increased from about 0.5 min/week to more than 4 hr/week. (auth)

45441 (BNL–50148) GIRD: COMPUTER PROGRAM FOR DESIGN OF SHUFFLE-DWELL GAMMA IRRADIATORS. Galanter, L.; Rosen, S.; Rizzo, F. X.; Bargiuk, L. (Brookhaven National Lab., Upton, N. Y.). Mar. 1969. 53p. Dep. CFSTI.

The shuffle-dwell irradiator is a system in which targets are rapidly moved laterally past one or more rectangular radiation sources and reside or dwell at a number of fixed positions on one or both sides of the source for a fixed period of time. Factors involved in optimum design of the irradiator include source economy, dose uniformity within product, product package shape and size, and product throughput. To encompass these factors, the GIRD code was written for the CDC-6600. It was specifically written to solve the meat irradiator design problems. (J.C.W.)

45442 (CONF-670337–1) INDUSTRIAL CLOSED-CYCLE GAS TURBINES FOR CONVENTIONAL AND NUCLEAR FUEL. Keller, C.; Schmidt, D. (Escher Wyss G.m.b.H., Zurich (Switzerland)). Dec. 6, 1966. 13p. American Society of Mechanical Engineers, New York $1.50.

From Conference on Gas Turbine and Products Show, Houston, Tex.

The operation of some newer fossil-fuel fired plants is described. The study results of European designs for nuclear gas turbines which can be built for the 600 to 1000-MW range are given. The special physical properties of air and helium and their influence on plant design are discussed. The combination of a closed-cycle gas turbine and a high-temperature reactor offers many possibilities for simplifications of nuclear plants and lowering capital costs. (auth)

45443 (HASL–211) CALCULATION OF STRATOSPHERIC AIR SAMPLE VOLUMES. Krajewski, Barbara (New York Operations Office (AEC), N. Y. Health and Safety Lab.). July 1969. 26p. Dep. CFSTI.

A practical working procedure is presented for calculating stratospheric air volumes sampled with the air filtering system known as the U-1 changer. A simple basic equation, describing the calculation of the volumes, uses information from the Flight Data Log and the Ambient Volumetric Flowrate and Interpolation Tables. The basic equation requires that the ambient flowrate be corrected for temperature, converted to standard conditions, and finally multiplied by the sampling time to obtain the standard volume of air sampled. The temperature correction factor and the ambient flowrate are chosen from the proper Interpolation Table and Ambient Volumetric Flowrate Table, respectively. Use of the tables depends upon knowledge of the flight altitude and evaluation of the indicated air speed. A sample calculation is presented together with the five calibrated Ambient Flowrate and two Interpolation Tables. (auth)

45444 (RISO-M–932) A NEW AUTOMATIC ^{60}Co IRRADIATION AND CALIBRATION FACILITY IN HEALTH PHYSICS DEPARTMENT. Boetter-Jensen, L. (Danish Atomic Energy Commission, Risoe. Research Establishment). July 12, 1969. 12p. Dep. CFSTI (U. S. Sales Only).

A new automatic Co-60 irradiation and calibration facility, controlled by compressed air, has been designed and constructed to meet the requirements of reliable gamma irradiation systems for the increasing work with instrument calibration, film and thermoluminescence dosimetry in the Health Physics Department. A description is given of the performance of the system and of some problems that occurred during the installation of the Co-60 sources. (auth)

45445 (UCRL–71889) CONCEPT FOR A GAS BUFFERED ANNULAR HEATPIPE FUEL IRRADIATION CAPSULE. Lee, J. D.; Werner, R. W. (California Univ., Livermore. Lawrence Radiation Lab.). July 31, 1969. 32p. (CONF-690910–1). Dep. CFSTI.

From Symposium on Developments in Irradiation Testing Technology, Sandusky, Ohio.

A nuclear fuel irradiation capsule capable of handling large ($\approx$300 W/cm^2) and varying fuel specimen heat fluxes while inherently maintaining nearly constant specimen temperature was conceived and two bench models successfully tested using potassium and sodium as the working fluids. Test temperatures were in the 700°C range and heat source temperatures were preserved within ±15°C while undergoing changes in power by factors of three. (auth)

45446 (Y-EF–329) VIRUS CONTROL LABORATORY. Allen, R. C.; McKenzie, J. A. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). May 20, 1969. Contract W-7405-eng-26. 35p. (CONF-690531–1). Dep. CFSTI.

From 8th Annual Technical Meeting of the American Association for Contamination Control, New York.

A laboratory designed for long term experiments on mice and rats to determine effects of irradiation and specific viruses on tumor induction and life span reduction is described. To obtain meaningful biological results, stray viruses and microflora native to man and animals must be controlled within the facility. The design of the facility, the environmental system, and strict operational procedures provide excellent contamination control in this bi-directional containment facility as substantiated by particle counts and microbiological testing. In addition to control of micro-

biologicals entering and exiting the building, unique features of the building design and environmental system for control of cross-contamination within the building are presented. (auth)

45447 IMPROVEMENTS IN OR RELATING TO THE MACHINING OF LARGE HOLLOW CYLINDRICAL WORKPIECES. Galbarini, Maso; Ramusino, Francesco Cotta (to Innocenti Societa' Generale Per l'Industria Metallurgica E Meccanica). British Patent 1,163,469. Sept. 4, 1969. Priority date Aug. 3, 1967, Italy.

An apparatus is described for machining internal or external surfaces of large tubular or cylindrical workpieces. The apparatus comprises a stationary base, an annular workpiece carrying platform, a vertical column anchored to the base inside the rotatable platform holding the adjustable machining head, a second fixed vertical column outside the rotatable platform holding a machining head, and adjustable guides. The apparatus is used for internal and external machining without repositioning the workpiece. (J.R.D.)

45448 THE SAMPLING SECTION OF THE ITREC PLANT AT ROTONDELLA. de Gregorio, Giuseppe. Com. Naz. Energ. Nucl., Notiz., 15: No. 6, 51-62(June 1969). (In Italian).

The sampling section of the Fuel Element Processing and Refabrication Plant (ITREC) of the Trisaia Nuclear Research Center, located at Trisaia Inferiore (Rotondella-Matera) is described. (auth)

45449 STARTING AND SHUTTING-DOWN REACTOR CIRCULATORS. Suter, P. Nucl. Eng. Int., 14: 641-7(Aug. 1969).

The overall characteristic of a mixed flow blower was determined for the various operating modes of reactor circulators. The blade vibrations in various operating states are indicated. By means of annular air curtains the blading passage of stationary blowers can be sealed against overpressures; and with suitably induced swirl a complete seal may be achieved. (auth) (UK)

45450 NUCLEAR PLANTS IN THE U. S. AS OF MAY 1969. Com. Naz. Energ. Nucl., Notiz., 15: No. 6, 101-5(June 1969). (In Italian).

The U. S. has at present 100 plants: 13 in operation, 46 under construction, and 41 planned. The main specifications of the plants are tabulated. (auth)

45451 CONSTRUCTION OF THE MIHAMA ATOMIC POWER STATION OF KANSAI ELECTRIC POWER COMPANY. Ono, Taimei (Kansai Electric Power Co., Osaka). Hatsuden Suiryoku, No. 99, 37-51(Mar. 1969). (In Japanese).

Construction is in progress for the Mihama atomic power station of Kansai Electric Power Company, aiming at completion in October 1970. About 90% of the civil engineering work has been finished; construction work also has nearly been finished, except on the turbines and related buildings. The atomic power station includes No. 1 and 2 reactor plants with 1,031 and 1,456 MW respectively, steam generators, pressure vessels, containment vessels, concrete shields, spent-fuel pits, fuel storages, turbine generators with condensers, etc. Concerning the construction of the Mihama atomic power station the following are discussed: an outline of the atomic power station; acquisition of the site, compensation for fisheries loss, and expenses for road construction; leveling of the site; construction of the foundations for reactor plants, including dewatering, rock-foundation improvement, and calculation concerning the ferro-concrete base; and treatment and construction of crushed rock-foundations. (NSA of Japan)

45452 NEW AUTOMATIC COLLIMATOR TO NARROW RADIOGRAPH BEAMS. J. Amer. Dent. Ass., 77: 240(Aug. 1968).

A device, developed by the PHS National Center for Radiological Health, for automatically narrowing radiograph beams to improve human health protection during x-ray examinations is described briefly. The device, an automatic collimator, can be used to reduce radiograph beams to film size or smaller. It can also maintain constant beam size as the distance is varied between the film and the x-ray tube. The collimator uses a servo system. The system employs mechanisms which sense radiograph film dimensions used for diagnosis and detect variations in film-to-tube distance. These data are relayed to a small motor which drives lead shutters to restrict the beam to widths which minimize patient exposure. Four models of the collimator have been made at the National Center for Radiological Health, and similar collimators are being developed by x-ray equipment manufacturers. (BBB)

45453 PROBLEMS OF RADIOACTIVE AEROSOL LOSS IN SAMPLING CONDUITS. Watanabe, Seiki (National Inst. of Radiological Sciences, Chiba, Japan). Hoken Butsuri, 4: 509-13(June 1969). (In Japanese).

A multichannel air monitoring system with a centralized sampling method is required in many facilities using radioactive materials. Conduits from sampling points are commonly used in such a monitoring system and result in aerosol losses due to particle deposition in the sampling conduits. Factors that contribute to aerosol loss, such as diffusion, impaction, gravity settling, electrical forces, and other phenomenon, are discussed. (TSS) (NSA of Japan)

45454 ON THE CONSTRUCTION OF A HARBOR FOR THE FUKUSHIMA ATOMIC POWER STATION OF TOKYO POWER COMPANY. Saeki, Shoji; Tezuka, Nobuo (Tokyo Electric Power Co.). Doboku Seko, 10: No. 4, 11-21(1969). (In Japanese).

The Fukushima atomic power plant being constructed in Japan is located near a shore lapped by rough Pacific waves, and requires an adjacent harbor so that heavy equipment can be transported to the site and seawater can be pumped to the power plant condensers. A description is given of the construction of the harbor and factors that affect this construction such as the configuration and geology of the area and the ocean variables including wave patterns, tides, and sand drift. (TSS) (NSA of Japan)

45455 INDUSTRIAL UTILIZATION OF STRONG RADIATION SOURCES MAKES PROGRESS. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl., No. 76, 17-19(Mar.-Apr. 1969). (In French).

The strong radiation sources presently available to industry in France are outlined. New radiation sources planned are the installation at Dagneux, the IRMA mobile radiation source, and the GAMINE experimental radiation source at Saclay. The principal applications of these devices are indicated. (J.S.R.)

Heat Transfer and Fluid Flow

Refer also to abstracts 45437, 45445, 45583, 45983, 46039, 47150, 47201, 47330, 47336, and 47341.

45456 (AERE-R-4506) FILM THICKNESS MEASUREMENT IN ANNULAR TWO-PHASE FLOW USING A FLUORESCENCE SPECTROMETER TECHNIQUE. PART II. STUDIES OF THE SHAPE OF DISTURBANCE WAVES. Hewitt, G. F.; Nicholls, B. (Atomic Energy Research Establishment, Harwell (England)). May 1969. 13p. Dep. CFSTI (U. S. Sales Only). UK 2s. 6d.

A set of experiments is described in which the shape in space of the large disturbance waves in annular flow was determined by use of the fluorescence technique, in order to obtain amplitude/time data, together with conductance probes to allow a simultaneous velocity measurement. The waves were typically of amplitude 5 times the mean liquid film thickness and had an axial length dimension of the order of ½ to 1 inch. (auth) (UK)

45457 (AERE-R-6070) INVESTIGATION OF INTERFACIAL PHENOMENA IN ANNULAR TWO-PHASE FLOW BY MEANS OF THE AXIAL VIEW TECHNIQUE. Hewitt, G. F.; Roberts, D. N. (Atomic Energy Research Establishment, Harwell (England)). June 1969. 33p. Dep. CFSTI (U. S. Sales Only). UK 10s. 0d.

By using a specially designed separator device it was possible to view annular two phase flow along the axis of a tube in such a way that a clear view of the oncoming flow, and particularly the wave structure, was obtained. Investigations of the effect of phase flowrates on the wave structure and the effect of length on wave development were carried out and are reported. In general, for a given gas flowrate, the activity of the waves and droplet entrainment increases with increasing liquid rate. At a given liquid rate, the amount of droplet entrainment and the amplitude and complexity of the interfacial structure decrease with gas rate as the regime transition between churn flow and annular flow is traversed. At high gas rates the amount of droplet entrainment increases again. In the churn flow region, over the range of gas flowrates studied, there was no visible sign of bridging across the tube. The studies of the effect of length showed how the disturbance waves grew continuously from the point of liquid injection. Frame-by-frame studies of high-speed movie films using the axial view technique indicated a number of possible break-up mechanisms. (auth) (UK)

45458 (ANL-7520(Pt.2), pp 331-42) TRANSIENT RESPONSE OF HEAT TRANSFER AND THERMAL STRESSES IN THICK WALLS OF SODIUM COMPONENTS. Sagawa, Norihiko; Kawahara, Seiji (Hitachi, Ltd., Tokyo (Japan)).

Thermal transients in a solid wall caused by changes of Na temperature are measured with a thick tube as a test section. Responses of heat transfer and of thermal stresses are calculated from the thermal data through analyzing heat conduction in the test section. Temperature changes of Na flow exert serious influence on heat flux of the surface and on thermal stresses in the test section, but exert little influence on the heat transfer coefficient of

the surface. This coefficient responds almost instantaneously to a new thermal condition and is affected by the thermal conductivity of the test section. The largest thermal stresses appear at the inner surface of the test section. Experimental results are presented. (auth)

45459 (CONF-670654-2) THEORETICAL MODEL OF MIXING BETWEEN HYDRAULICALLY INTERCONNECTED CHANNELS. Verheugen, A. N. J.; van der Ros, Th.; van der Walle, F.; Spigt, C. L.; Bogaardt, M. (Technische Hogeschool, Eindhoven (Netherlands)). May 1967. 31p. Dep.

From Symposium on Two-Phase Flow, Bournemouth, England.

An attempt has been made to describe the process of gas and liquid exchange between vertical hydraulically interconnected channels and its effects on the flow redistribution. Derivations of equations describing the hydrodynamics and heat transfer characteristics of a two-phase flow in a single channel under stationary conditions are given. The basic equations are formed by the laws of conservation of mass and momentum for the mixture, and of the laws of energy conservation for the liquid and gaseous phase. These equations can be solved if the equations of state, the correlation functions for the slip factor, friction factor and heat division parameter, and the boundary conditions are considered. Mixing terms have been derived which describe the interaction effects between the channels and are added to the basic equations. Two possible mechanisms of mixing considered are: a microscopic transport of mass, momentum, and energy because of differences in velocity, temperature, and void concentration between the neighboring channels, called turbulent mixing; and a macroscopic transport of mass, momentum, and energy because of pressure differences between the neighboring channels, defined as cross-flow. An expression for the turbulent mixing can be obtained by defining a mixing length. An expression for the mass, momentum, and energy transport due to cross flow is obtained from the assumption that a pressure difference between the channels will lead to a radial flow velocity given by equating the pressure difference with a pressure drop coefficient for the gap between the channels multiplied by the average density of the donating channel and the cross flow velocity squared. The channels are divided into a number of nodes and the equations are solved for the different nodes in succession. The equations have been formulated in detail and a digital computer program has been written. (J.C.W.)

45460 (CONF-670654-3) PROGRESS IN ANALYSIS OF EXPERIMENTAL DATA TO TEST HAMBO SUBCHANNEL MODEL. Bowring, R. W. (Atomic Energy Establishment, Winfrith (England)). May 1967. 6p. Dep. CFSTI (U. S. Sales Only).

From Symposium on Two-Phase Flow, Bournemouth, England.

The progress in the development of the HAMBO subchannel code through the analysis of experimental hydraulic and burnout data for rod clusters is described. Analysis of experimental single phase and two phase hydraulic data confirmed that the theoretical mixing model used in the code was approximately correct. Burnout analysis of experimental cluster data showed that the predicted burnout power was not sensitive to the hydraulic model; a gross misrepresentation only changed the burn-out power by up to 4%. Burn-out analysis also showed that round tube and other single channel burn-out correlations were not valid for subchannel geometries. New subchannel burnout correlations were developed for conditions of uniform heat flux and 1000 psia from data for small clusters with 4 to 19 rods. The RMS error for the 233 data points analyzed was about 6%. When the correlation was extrapolated to 37-rod 12 feet long clusters, the RMS error was virtually unchanged. The correlation could also be applied satisfactorily to clusters which were previously regarded as abnormal and which could not be correlated accurately on a mixed flow basis. (J.C.W.)

45461 (EIR-145) FLOW FORM, STEAM VOLUME FRACTION, AND PRESSURE DROP IN TWO-PHASE FLOW OF WATER-STEAM IN TUBES. Kuetuekcueoglu, A. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). June 1969. 158p. (In German). Dep.

The local distribution of the liquid and the mean steam volume fraction can be determined from the attenuation of a collimated γ beam through a tube through which a two-phase mixture of water and steam is flowing. Simultaneously the total pressure drop and the friction loss were determined. Measurements were made on a high pressure circuit in the pressure range from 10.4 to 36.6 bar, the mass flow density from 990 to 4066 kg/sec m^2, and mass flow ratio of the steam from 0.04 to 0.58. From a comparison of the respective measurement ranges with different data for the determination of the flow form, it was found that with the exception of a few measurement points with low mass flow, densities and mass flow ratios of the steam ring flow were present. In the region studied, the pressure and the mass flow density affected the mean steam volume fraction only insignificantly over the pipe cross section. In vertical tests the measurement results were higher than in the horizontal flow direction. As the heat charge increased the mean steam volume fraction increases. In the vicinity of the channel wall the radial steam volume fraction pattern can be described with a logarithmic function. From the radial steam volume fraction pattern the density of the liquid film on the channel wall can be determined approximately. High mass and heat flow densities and mass flow ratios of the steam lead to smaller film thicknesses. At high mass flow densities the fraction of the pressure difference was small. The pressure difference at high heat charge can affect significantly the total pressure drop. (tr-auth)

45462 (EIR-155) HEAT TRANSFER MEASUREMENTS WITH SUPERHEATED STEAM IN TUBES AND CONCENTRIC ANNULAR CHANNELS. Kuetuekcueoglu, A. (Eidgenoessisches Institut fuer Reaktorforschung, Wuerenlingen (Switzerland)). June 1969. 64p. (In German). Dep.

The effects of the Prandtl number, the Reynolds number, the temperature change at the boundary layer, and the L/d_h ratio were investigated on the basis of heat transfer measurements with superheated steam in tubes and concentric rings. The results were compared with existing data. The measurements were carried out in the pressure range from 19 to 33 bar, steam temperature range from 241 to 470°C, Reynolds number range from 9×10^4 to 3×10^5, and Prandtl number from 0.9 to 1.2. If the material value is related to the steam temperature, then a correction, dependent not only on the temperature ratio of the water and steam, but also on the pressure and temperature, is necessary. If the material value is related to the film temperature, then no correction is necessary. The relatively large L/d_h effect can be explained by the thermal formation of the flow. In ring channels about 10% lower heat transfer numbers were obtained under comparable conditions than in tubes. This difference was attributed for the most part to the different temperature and velocity distributions in the tube and in the one-sided heated rings. Under certain simplifying assumptions, the Hall measurement results in tubes were transformed so that the heat flow density and temperature patterns in the internal partial channel up to the zero shearing stress line were similar to that in tubes or in a partial channel of a tube bundle. The transformed values agreed well with the results obtained with tubes. (J.S.R.)

45463 (LIB/Trans-210) MEASUREMENT OF THE CRITICAL HEAT-FLUX-DENSITY OF SUBCOOLED WATER IN TUBES AT FORCED FLOW. Burch, E.; Hufschmidt, W. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). Translated by J. B. Hopkinson (Australian Atomic Energy Commission Research Establishment, Lucas Heights), from report EUR-2432. 34p. Dep.

An abstract of this paper, prepared from the original language, appeared as NSA 19: 32383. (auth)

45464 (NP-17971) CAVITATION THRESHOLD OBSERVATIONS IN WATER AT 14.5 kHz. Report No. 01357-10-T. Huang, Y. C.; Hammitt, F. G.; Solomon, L. P.; Kling, C. L. (Michigan Univ., Ann Arbor. Cavitation and Multiphase Flow Lab.). June 1969. 19p.

Measurements of cavitation incidence and desinence threshold pressure were made at 14.5 kHz in a vibratory horn facility in water over the temperature range between melting and boiling points at one atmosphere. These were compared with similar results previously obtained with liquid sodium over its comparable temperature range, and relatively close agreement in terms of pressure magnitudes as a function of a reduced temperature was found. (auth)

45465 (WW-30-M-75) STUDY OF FLOW DISTRIBUTION IN A TWO-CHANNEL TEST SECTION WITH AN AIR-WATER MIXTURE. Bestenbreur, T. P. (Technische Hogeschool, Eindhoven (Netherlands)). May 1967. 114p. Dep.

Flow distribution in a reactor core was studied. Simplification measures included using a two-channel system with air and water as the flowing media. Mass flow measurements were made of air and water at the outlet of the test section. Static pressures and pressure differences were measured at different levels along the test section, and water velocities were measured at the inlet of the test section. Void fraction measurements were made at different levels along the test section. Experimental conditions included asymmetric injection of compressed air into channel 1 at different levels (there were 4 levels), constant inlet mass flow of water (439×10^{-3} kgs^{-1}), and steady-state flow. (J.C.W.)

45466 IMPROVEMENTS RELATING TO HEAT EXCHANGERS. Nicoll, Wilfred Charles (to United Kingdom Atomic Energy Authority). British Patent 1,158,981. July 23, 1969. Filed Feb. 22, 1966.

Heat exchangers are described in which separate fluid streams

can be passed in common heat exchange relationship with another fluid or, in the case of two streams, with one another. In the system described the heat exchanger includes a tube bundle composed of a set of tubes for each of a number of fluid streams and a heater structure divided by tube plates into separate header compartments, the successive tube plates being penetrated by a decreasing number of tube sets, and each set opening into the respective header compartment. The "in-line" arrangement of the header compartments makes the system particularly suitable for the kind of heat exchanger in which a sheath duct contains the tube bundle. The sheath duct then acts as a shell to conduct a second fluid over the tubes or may contain an intermediate heat transfer liquid. The sheath duct extends between a pair of header structures. The tube plates may be arranged in parallel, and the sheath duct may be of hairpin configuration. Several alternative arrangements are described. (UK)

45467 HEAT CONDUCTION IN REACTOR FUEL ELEMENTS. Hetsroni, G.; Wacholder, E.; Haber, S. (Technion–Israel Inst. of Tech., Haifa). Nucl. Sci. Eng., 37: 329-36(Sept. 1969).

An analytical solution is presented for the general differential equation describing the temperature fields in the fuel and in the clad of a reactor fuel element. Both the two-dimensional fuel plate and cylindrical fuel rod are considered. The method of solution is easily adaptable to any desired set of boundary conditions and to an arbitrary distribution of volumetric heat generation, which can be expanded in an appropriate Fourier series. (auth)

45468 METHOD AND APPARATUS FOR THE DETECTION OF BOILING IN LIQUIDS. Grass, Gunther; Kottowski, Heinz (to EURATOM). British Patent 1,161,332. Aug. 13, 1969. Priority date Nov. 5, 1965, Germany.

A method is given for detecting boiling in a liquid. A monitoring device which is sensitive to pressure changes caused by formation and or/condensation of vapor bubbles is used. An indicating, recording, and controlling device responsive to the output of the pressure-sensitive device is used. Numerous detectors are used to monitor the cooling ducts of a nuclear reactor and placed above the reactor core, but immersed in the coolant. Detection of boiling by pressure-wave measurement is accompanied by very short response periods because the propagation velocity of pressure waves is a multiple of the propagation velocity of temperature. (J.C.W.)

45469 INFLUENCE OF ARTIFICIAL ROUGHNESSES ON THE CRITICAL HEAT FLUX DENSITY UNDER FORCED CONVECTION CONDITIONS. Burck, E.; Hufschmidt, W.; de Clercq, E. Atomkernenergie, 14: 305-8(Sept.-Oct. 1969). (In German).

The critical heat flux density (burnout) of subcooled water in annular test sections with inner heated smooth and rough tubes under forced convection conditions has been measured. Different forms of artificial roughness (sandroughness, knurls, and threads) have been investigated, the roughness depth has been varied between 2.6 μ and 0.3 mm. Within the range of test parameters: outled pressure $P_0 = 3 - 31$ bars, mass flow density $q_m = 250 - 3000$ kg m^2 s, outled subcooling $T_s - T_0 = 0 - 150°C$ and $h_s - h_0 = 0 - 60 \cdot 10^4$ Ws/kg the increase of the critical heat flux density by the roughnesses was very small (≤20%). This increase of critical heat flux density, however, was very small compared with the increase of normal convective heat transfer coefficients on identically roughened surfaces. (auth)

45470 CALCULATION OF FLOW AND THERMODYNAMIC VARIABLES OF AN ARGON–CESIUM MIXTURE BEHIND A NORMAL SHOCK. Rozhdestvenskii, I. B.; Olevinskii, K. K.; Shatilov, A. P. Heat Transfer–Sov. Res., 1: No. 4, 238-47 (July 1969).

A high-speed computer was used for calculating the flow and thermodynamic variables of an Ar + Cs mixture behind a normal shock in a shock tube with a preheated low-pressure chamber. The calculations were made for initial temperatures $T_1 = 300$, 400, 500, 600, and 700°K (shock-tube wall temperatures) and initial pressures $p_1 = 1$, 10, 100 mm of Hg in a range of temperatures behind the shock of up to 7000°K in 100°K increments. The fraction of cesium in the mixture was determined by its saturated vapor pressure at T_1. The following were computed: ratio of the shock-wave velocity to the speed of sound ahead of the front, temperature, pressure and density behind the shock front, flow velocity behind the shock front, molecular weight of the mixture, enthalpy and entropy, specific heat of the mixture, speed of sound, etc. The results are presented in tables and graphs. (auth)

45471 CRITICAL VELOCITY IN TWO-PHASE FLOW. Dryndrozhik, E. I. Heat Transfer–Sov. Res., 1: No. 4, 77-88 (July 1969).

A survey of theoretical and experimental studies on the discharge of saturated liquids and two-phase vapor-liquid streams from tubes and nozzles is presented. It was found that no agreement exists at present about the definition of critical discharge velocity and about the factors on which it depends. Positive recommendations are made about the parameters which should affect the critical discharge velocity of two-phase flows. (auth)

45472 STUDY OF THE BOILING CRISIS WITH WATER IN ROD BUNDLES. Efimov, V. A.; Trutnev, D. P.; Marchenko, L. D. Heat Transfer–Sov. Res., 1: No. 4, 48-56(July 1969).

Successively more complicated models of three-rod assemblies in tubes with steam–water flow were used to study the effects of flow variables on burnout. The geometric characteristics of the assembly are: rod diameters d = 10 mm, s/d = 1 to 1.43, d_{eq} = 6.5 to 9.3 mm, l = 0.1-0.42 m. Flow variables were varied within the following limits: p = 98 and 49 bars, $\overline{w\rho}$ = 300-44 kg/m^2-sec, $\overline{x}_{cr} = -0.4 \mp 0.5$. As a result of timely power switch-off at the on set of burnout and subsequent inspection of the assemblies, it became possible to establish the fact that burnout started in "hot cells" which were predetermined by calculation. This served as a direct proof that the value of q_{cr} is determined by the highest enthalpy in hot cells. The experimental data in coordinates $q_{cr} = t(x_{cr}, w\rho)$ break up into clusters depending on the extent of nonequivalence of the cells. This clustering decreases with an increase in $\overline{w\rho}$ and $\overline{x}_{cr}$ (for $\overline{x}_{cr} > 0$). The character of the relationship $q_{cr} = t(\overline{x}_{cr})$ for s/d = 1.2-1.43 was similar to the same relationship for tubes, while in respect to absolute values it came close to curves for tubes (d = 8.9 mm, l ≥ 0.2 m) as the cell unequivalence parameter decreased to 1. The importance of maintaining and monitoring the specified position of rods in the duct is emphasized, since nonrecorded disturbances of geometry (due to electrical forces or due to one-sided overheating of the rods, etc.) result in distortion of the experimental data. (auth)

45473 STUDY OF THE EFFECT OF ROD BUNDLES ON BOILING CRISIS. Efimov, V. A.; Marchenko, L. D.; Trutnev, D. P. Heat Transfer–Sov. Res., 1: No. 4, 42-7(July 1969).

Successively more complicated experimental models of rod bundles in heated tubes, progressing from single-rod to three-rod assemblies, were used to determine the effects of the rod bundle variables on burnout in tubes. Tables of experimental data on mass flow, inlet temperature, heat transfer, and critical heat are presented for the different test conditions. (L.C.L.)

45474 SPECIAL HYDRODYNAMIC EFFECT ON THE BOILING CRISIS IN TUBES. Babarin, V. P.; Sevast'yanov, R. I.; Alad'ev, I. T. Heat Transfer–Sov. Res., 1: No. 4, 34-41(July 1969).

The presence of two crisis mechanisms at high steam qualities was established on the basis of tests with straight tubes. A device is suggested for intensifying turbulent transfer of liquid drops from the central water-steam nucleus of the flow to the heated duct wall and thus increasing q_{cr} from the boiling liquid. Experimental data are presented. (auth)

45475 REGARDING A SPECIAL FEATURE OF BOILING CRISIS IN CHANNELS. Sevast'yanov, R. I.; Alad'ev, I. T. Heat Transfer–Sov. Res., 1: No. 4, 28-33(July 1969).

The onset of boiling crisis at the entrance to channels with a thermal load decreasing along the channel is explained by analyzing the increase in the vapor quality along the tube with this type of nonuniform heat load distribution. A method of explaining the hydrodynamics of the flow at the channel entrance is suggested. Experimental data with a worm-type turbulence promoter in tubes with a heat flux decreasing with length and in tubes with increasing heat flux without turbulence promoter are given. (auth)

45476 HEAT TRANSFER TO BOILING POTASSIUM IN UNIFORMLY HEATED TUBES. Alad'ev, I. T.; Goriov, I. G.; Dodonov, L. D.; Fedynskii, O. S. Heat Transfer–Sov. Res., 1: No. 4, 14-26(July 1969). (BNL-tr-251).

The results of a heat transfer study for boiling potassium in uniformly heated tubes are presented. The effects of pressure on both heat transfer and critical heat fluxes were studied. The nonuniformity coefficient of heat generation X (q_{max}/q_{min}) did not exceed 1.5. Molybdenum tubes with an internal dia. of 4 mm, l/d of 30, 50, and 82 were used with flow parameters of mass velocities of up to 270 kg/m^2/sec, heat flux densities up to 1400 kw/m^2, vapor qualities up to 0.8, and pressures of 1.5×10^4 to 4.1×10^5 newton/m^2. The investigation showed that the rate of heat transfer is independent of the mass velocity of the two-phase potassium flow and is proportional to the 0.7 power of the heat flux density. In the range of pressures investigated, an increase of pressure causes a slight increase in the heat transfer rate. No effect of vapor quality on heat transfer rate was discovered. A study of critical heat fluxes in molybdenum and stainless steel tubes showed that the critical heat flux increases with the mass velocity of the stream and decreases with an increase in l/d. No effect on

pressure on the critical heat flux was discovered. Empirical equations for heat transfer coefficients and critical heat flux densities for the boiling of potassium in uniformly heated tubes are proposed for the range of conditions and geometries investigated. (auth)

45477 HYDRODYNAMICS OF A TWO-PHASE FLOW OF POTASSIUM IN TUBES. Alad'ev, I. T.; Gavrilova, N. D.; Dodonov, L. D. Heat Transfer–Sov. Res., 1: No. 4, 1-13(July 1969).

Data from a study of true void fractions and hydraulic resistances for potassium vapor flow in tubes are presented. Vapor fractions were determined by measuring electrical conductivity of the two-phase flow. The ranges of experimental variables were: p of 1 bar, mass velocity of 50 to 500 kg/m^2/sec and quality of 0 to 50%. The experimental data were compared with the semi-empirical Armand equation for water-steam flows and this equation is recommended for the calculation of the void fraction in a potassium vapor flow. The hydraulic resistances of a potassium vapor flow were measured at pressured 1.0 and 1.5 bar in a range of mass velocities from 150 to 500 kg/m^2/sec. The results showed that friction factor data for a potassium vapor flow are well described by both the Armand and the Martinelli-Lockhart equation for water-steam flows. (auth)

Isotope Technology

Refer also to abstracts 45400, 45441, 45455, 45485, 45496, and 47235.

45478 (BMwF-FBK–69-23) ISOTOPIC GENERATOR USING PHOTOELECTRIC CONVERSION. Scharmann, A.; Wegner, U. (Giessen Univ. (West Germany). Physikalisches Institut (I)). June 1969. 28p. (In German). Dep.

The mode of operation of photoelectric isotopic generators which consist of two energy conversions was investigated. The theoretical limitations of conversion were discussed and tested by three isotopic generators with specific activities of 7.5, 100, and 55 Ci ^{147}Pm/g ZnS. Possibilities for the improvement of the efficiency are proposed. (auth)

45479 (CNM-R–2(Vol.1), pp 46-57) THE NUCLEAR PROGRAM IN MEXICO. Fernandez, Carlos Graef (Comision Nacional de Energia Nuclear, Mexico City). (In Spanish).

These activities are discussed under the following headings: training of scientific and technical personnel; scientific investigations; applications in industry, agriculture, and medicine; and radiological security measures. (M.C.G.)

45480 (SC-DR–69-326) IMPACT TESTS OF HEAT SOURCE FOR EARLY APOLLO SEISMIC EXPERIMENT PACKAGE. Dalby, W. J. (Sandia Labs., Albuquerque, N. Mex.). June 1969. 62p. Dep. CFSTI.

Twenty-six impact tests of the heat source for the Early Apollo Seismic Experiment Package (EASEP) were completed. These tests were conducted to permit the selection of an acceptable configuration and to evaluate the adequacy of the design selected. The results of the series 2 impact tests indicate that the heat source may reasonably be expected to contain the fuel after impact under the postulated accident conditions. (auth)

45481 ON THE PRESENT STATE OF LABORATORIES FOR RADIOACTIVE ISOTOPES IN NATIONAL UNIVERSITIES OF JAPAN. Oyama, Cho (Ministry of Education, Tokyo). Gakujutsu Geppo, 21: 688-97(Jan. 1969). (In Japanese).

Since several radioisotopes were imported for the first time in 1949, many have been used for educational purposes and for research activities in national universities of Japan. At present, radioisotope laboratories present in 50 national universities and 196 facilities, and the number of users per year amounts to 2931 faculty members and 2517 students. Maintenance expenses of radioisotope facilities, physical check-up expenses, and expenses for student training cost 13,405 × 10^3 yen in 1956 fiscal year, but increased to 209,209 × 10^3 yen in 1968 fiscal year. Most frequent users are faculty members and students from the medical department. In most national universities, experimental training in radioisotopes is included in the curricula. Data and lists of names of national universities and facilities using radioisotopes are given with physical size, nuclides handled and the number of users. (NSA of Japan)

45482 NEW METHOD OF SEPARATING ISOTOPIC SPECIES AND DEVICE FOR CARRYING OUT THIS METHOD. (to Societe Nationale des Petroles D'Aquitaine). British Patent 1,162,291. Aug. 20, 1969. Priority date Feb. 15, 1966, France.

A long narrow tube is filled with a molecular sieve or porous powder having surface adsorption properties and is inert to a continuously flowing vector gas. Periodic injections of a predetermined quantity of isotopic mixture to be separated is released into the vector gas. The concentration of the isotopic mixture is determined by a mass spectrometer having ion collectors producing an electric current proportional to the instantaneous concentration of each of the isotopic species. A method is also described for the separation of isotopes. By repeating the operation either on columns mounted in series or by recycling the enriched mixture in the first column, the factor of enrichment can be increased or the isotopes can be completely separated. (J.C.W.)

Materials Testing

Refer also to abstracts 45225, 45438, 45480, 45992, and 46036.

45483 (ANL–7520(Pt.1), pp 345-73) DETECTION OF SMALL LEAKS BY HYDROGEN MEASUREMENTS IN A SODIUM-HEATED STEAM GENERATOR. Birault, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Brachet, A. (Electricite de France, Chatou. Centre de Recherches et d'Essais); Cambillard, E. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Coron, J.; Lannou, L.; Rault, C. (Electricite de France, Chatou. Centre de Recherches et d'Essais).

Conventional methods for leak detection, such as plugging indicator, nickel diaphram associated with a Pirani gage and cover-gas chromatography, were compared with a new method based on a Ni diaphragm associated with a mass spectrometer for the detection of hydrogen leaks in steam generators. Physicochemical mechanisms that enter into a process for detecting water leaks in industrial steam generators connected to a fast sodium-cooled reactor were also studied. Theoretically, the advantages (basically sensitivity) of the various methods of water-leakage detection in a steam generator were considered. Measurements of diffused-hydrogen flux for nickel diaphragms were made for argon- and sodium-type detectors. The results acquired permit the design and dimensioning of a leak detection system for industrial application. Tests performed at Grand Quevilly are described. Physical data for the NaK alloy used in the secondary circuit loop at Grand Quevilly are given. (J.C.W.)

45484 (ANL–7520(Pt.1), pp 374-83) STATUS OF SODIUM-WATER REACTION TEST WORK AT INTERATOM. Dumm, K.; Mausbeck, H.; Schnitker, W. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)).

Pinhole tests, leak tests with steam generator models of various sizes, and leak detection tests were made in different vessel geometries. The facility (ASB) for safety tests for the fast breeder reactor is described. Three computer codes were developed for the description of the sodium–water reaction in vessels. (J.C.W.)

45485 (SC-DR–69-346) IMPACT TESTS OF PLASMA FIRED $^{238}PuO_2$ MICROSPHERES. Dalby, W. J. (Sandia Labs., Albuquerque, N. Mex.). July 1969. 219p. Dep. CFSTI.

Rigid capsules containing production grade plasma fired $^{238}PuO_2$ microspheres were impacted at velocities up to 456 feet per second against various targets. Particle size analyses of the impacted microspheres showed that from 0.01 to 13 weight percent was in the less than 10 micrometer range and from 0.01 to 6 weight percent was in the less than 3.5 micrometer range. (auth)

45486 HELIUM SWEATING TIGHTNESS CONTROL OF FUEL ELEMENTS. Maurice, L. Energ. Nucl. (Paris), 11: 286-91 (July 1969). (In French).

The helium sweating method for the final control of fuel element tightness makes possible an efficient check of clad tightness. After a short summary on the leak-detection, a description is given of a group of leak detection stations, as well as installations that operate in plants for fuel element production. (auth)

45487 RADIOGRAPHIC INSPECTION FOR NUCLEAR PRESSURE VESSELS BY ELECTRON LINAC USED FOR NONDESTRUCTIVE TEST. Fujita, Hyota; Irie, Koichi (Mitsubishi Electric Corp., Tokyo). Mitsubishi Juko Giho, 6: 398-405(July 1969). (In Japanese).

The electron Linac Model ML-15R was developed for nondestructive testing. The main features of this apparatus, which employs a 5 MW klystron as a microwave power source, are its ample output and steady operation. The acceleration unit, about 3 m in length, can be driven in 3 directions and rotated both in the horizontal and the vertical planes. The maximum energy of the electron beam is 12 MeV and x-ray output can be continuously varied in a wide range from 2000 to 10 R/min at 1 m. Penetrameter sensitivity with wire and ASME type was compared for steels with thicknesses from 23 to 360 mm. A formula for image qualification indicator (penetrameter) sensitivity for different hole diameters on the basis of image unsharpness was developed. (auth) (NSA of Japan)

Protective Structures

Refer also to abstract 45436.

45488 PROTECTING PUMPING STATIONS AGAINST NUCLEAR ATTACK. Becker, Elmer W. J. Amer. Water Works Ass., 61: 392-4(Aug. 1969).

The growth of the Milwaukee Water Works is discussed. With the advent of the population increase, a new source of raw water was needed and the use of Lake Michigan began. The new pumping stations on the lake front were designed to resist bomb blast pressure with interior protection against fallout from nuclear fission products. The three station structures and equipment mountings are discussed. (J.C.W.)

Radioactive Material Handling

45489 (ANL-7520(Pt.1), pp 125-7) TEST PROGRAM FOR COMPONENTS IN LIQUID SODIUM. Arend, E. (Gradel S. A., Steinfort (Luxembourg)); Wagener, H. (Arbed S. A., Dommeldange (Luxembourg)).

The feasibility of dismantling irradiated fast power reactor fuel assemblies and of recovering fuel pins under sodium at 200°C is discussed. Mechanisms of the test rig are described and design criteria for the under-sodium testing of mechanical components are given. (J.C.W.)

45490 (BARC-400) INVESTIGATION OF MATERIALS AND METHODS FOR FIXATION OF LOW AND MEDIUM LEVEL RADIOACTIVE WASTE IN STABLE SOLID MEDIA. Final Report. Rastogi, R. C.; Sehgal, J. D.; Chandra, Keshava; Thomas, K. T. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 262p. (IAEA-3431-5). Dep.

The Trombay Glass Process was developed to condition secondary wastes by fixing them in glass prior to their disposal. Low and medium level radioactive wastes are rendered stable, compact, and nonleachable. Chemical compositions were developed to incorporate secondary wastes-spent vermiculite, sludge cake, and incinerator ash-in glass, individually or in combination, by the addition of suitable inexpensive fluxes. Thermal and radiation stability and leaching characteristics during storage conditions of selected glasses were evaluated. A volatilization study of ruthenium and cesium was carried out to suppress volatility from glass mix during firing and to develop different silicious materials coated with iron oxide for the retention of ruthenium and cesium from gas streams. Corrosion of metal alloys in molten manganese, vermiculite, and sludge cake glasses was studied to evaluate their suitability as materials of plant construction. The Trombay Glass Process incorporates secondary wastes in glass. It consists of a mixing and charging mechanism for charging glass formers and waste to the furnace, controlled combustion system for burning butane gas with air, discharge mechanism for removal of glass from the furnace, and off-gas cleaning system to bring down the activity levels of off-gases within permissible limits before releasing to the atmosphere. Economics was evaluated and results indicate that the conditioning of wastes by the process ensures safety with added economy in the sludge and sludge cake wastes. With vermiculite waste, the process ensures safety, but it costs 30 to 90% more than the disposal practice without treatment. (J.C.W.)

45491 (ORNL-TM-2531) ANALYSIS OF THE OAK RIDGE NATIONAL LABORATORY GARDEN CARRIER NO. 2. Klima, B. B. (Oak Ridge National Lab., Tenn.). Sept. 1969. Contract W-7405-eng-26. 87p. Dep. CFSTI.

An analytical evaluation of the ORNL Garden Carrier No. 2 was made to demonstrate its compliance with the regulations governing packages in which radioactive material is shipped. Computational procedures were used to determine the structural integrity and thermal behavior of the cask with respect to the general standards for packaging, structural standards, standards for normal conditions of transport, and the standards for the hypothetical accident conditions. The results of this evaluation show that the cask complies with all the applicable regulations. (auth)

45492 (ORNL-tr-2189) HEAT PROBLEMS POSED IN THE PACKING OF HIGHLY RADIOACTIVE MATERIALS. Labrousse, M.; Mordchelles-Regnier, G.; Michel, C.; Pirovano, A. Translated by F. Gregg Mansfield (Oak Ridge National Lab., Tenn.), from Energ. Nucl. (Paris), 9: 245-51(1967). 20p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 22: 293.

45493 (PB-184096) RADIUM DISPOSAL PROJECT. Pettigrew, George L. (National Center for Radiological Health, Rockville, Md.). Feb. 1967. 10p. (MORP-67-2). CFSTI.

Radium waste disposal activities are summarized. Data, supplied with surplus sources, are tabulated with special consideration given to medical sources. Source types, age, and leakage are compared. (auth) (USGRDR)

45494 DECONTAMINATION OF THE COMBUSTION PRODUCTS FORMED BY INCINERATION OF RADIOACTIVE WASTES. Hirling, Jozsef. Atomtech. Tajek., 12: 48-51(Jan. 1969). (In Hungarian).

The basic principles of ashing equipment for the treatment of aerosols and volatile compounds arising during the disposal of radioactive wastes is described in detail. (auth)

45495 METHODS FOR TESTING PACKAGE OF RADIOACTIVE MATERIALS. Biro, Tamas (MTA Izotop Intezete, Budapest). Atomtech. Tajek., 11: 515-20(Oct. 1968). (In Hungarian).

Based on literature data on possible accidents during transport, criteria for construction of shipping containers and test methods are given. (auth)

45496 MATERIALE NUCLEARE. (Nuclear Material). Maxim, I. V. Bucuresti, Editura Academiei Republicii Socialiste Romania, 1969. 443p. 30 lei.

Detailed data are given on the management, disposal, and processing of radioactive waste. Practices in the treatment of low- and intermediate-level radioactive waste, fuel processing, ground storage of high-level radioactive waste, solidification, and disposal into the sea are discussed. Tables of materials are given considering uranium mineral concentration and enrichment of uranium in ^{235}U. Preparation, properties, and structure of thorium, plutonium, beryllium, and zirconium are described. The structure and properties of liquid fuels, moderator and coolant materials, ceramics, and shielding materials are evaluated. (R.V.J.)

45497 WHY RECOVER THE USED NUCLEAR FUELS? Anderson, Cleve R. (General Electric Co., Santa Clara, Calif.). Elec. World, 170: No. 15, 26-8(Oct. 7, 1968).

The reasons for recovering used reactor fuels are outlined as: conservation of uranium reserves; source of refueling supplies; superior handling of radioactive waste; and improved economy of the overall fuel cycle. (L.C.L.)

45498 DECONTAMINATION CHARACTERISTICS OF EVAPORATION FACILITIES TREATING RADIOACTIVE LIQUID-WASTES AT THE KYOTO UNIVERSITY RESEARCH REACTOR INSTITUTE. Tsutsui, Tenson; Iwai, Shigehisa; Shimoura, Kazukuni; Yokochi, Akira; Koyanaka, Yoshio; Kimura, Syojiro; Utsuro, Kayoko. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 195-202 (Oct. 1968).

The evaporation facility for radioactive liquid wastes which has been designed for a treatment capacity of 500 kg/hr is described. The decontamination efficiencies of the evaporator and its accompanying entrainment separators of cyclone and Raschig-ring packed tower were measured by using a test liquid waste, the boil-up rates of which varied from 200 to 1,000 kg/hr, with strontium nitrate solution as a tracer. Decontamination factors in a range of 10^5 to 10^6 between the still pot and the distillate have been obtained in each case when the evaporator with either cyclone or packed tower was used as the entrainment separator. (auth)

45499 DECONTAMINATION CHARACTERISTICS OF LOW-LEVEL RADIOACTIVE LIQUID-WASTE TREATMENT PLANT AT THE KYOTO UNIVERSITY RESEARCH REACTOR INSTITUTE. Tsutsui, Tenson; Iwai, Shigehisa; Koyanaka, Yoshio; Shimoura, Kazukuni; Yokochi, Akira; Kimura, Syojiro; Utsuro, Kayoko. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 187-94(Oct. 1968).

The results of the test run on the performance of the chemical flocculation-sedimentation-filtration plant are reported. The test was carried out with non-radioactive strontium tracer, specifically testing for the treatment of the low-level radioactive liquid wastes of below 10^{-5} μCi/ml which will come from the Research Reactor Institute of the Kyoto University. It was revealed that an over-all decontamination factor of more than 10 could be ensured by this plant, under the usual dosing conditions with coagulant of 200 ppM (as Fe), precipitant of 100 ppM (as Na_2CO_3), and pH of 11. The result of bench-scale jar test complied well with the performance of the plant. Centrifuge and freezing-thawing processes were applied to the dewatering of the sludge thereby yielded, gaining a volume reduction ratio of 1/500 to 1/1,000. (auth)

45500 TREATMENT AND DISPOSAL OF RADIOACTIVE LIQUID- AND SOLID-WASTES AT THE KYOTO UNIVERSITY RESEARCH REACTOR INSTITUTE. Iwai, Shigehisa; Tsutsui, Tenson; Takamatsu, Takeichiro; Oshio, Toshiki; Shimoura, Kazukuni. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 171-86(Oct. 1968).

In order to dispose of the radioactive liquid and solid wastes, a

treatment plant has been installed in the Kyoto University Research Reactor Institute. The basic principles and scope of these wastes are discussed. (auth)

45501 SAFETY HANDLING FACILITIES AND EQUIPMENTS IN HOT LABORATORY OF RESEARCH REACTOR INSTITUTE KYOTO UNIVERSITY. Iwata, Shiro; Nishikawa, Sataro. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 137-61(Oct. 1968).

The safety handling facilities and equipment in the Hot Laboratory of the Research Reactor Institute of Kyoto University are reported. Descriptions of the facilities and equipments are described successively. The characteristics of the equipment, the results of radiation shielding tests for the hot cave and the junior caves, and the ventilation system and ventilative capacity of these facilities are also reported. (auth)

Vacuum Engineering

Refer also to abstracts 45596 and 46888.

45502 LARGE BAKABLE HIGH VACUUM VALVE. Baxter, William J.; Dusman, Richard J. (General Motors Corp., Warren, Mich.). Rev. Sci. Instrum. 40: 1355-6(Oct. 1969).

A large stainless steel high vacuum valve which is bakable to 450°C and will contain a vacuum of 10^{-10} torr is described. (B.G.D.)

INSTRUMENTATION

Radiation Detection Instruments

Refer also to abstract 46555.

General Detectors and Monitors

Refer also to abstracts 45453 and 46860.

45503 (BARC–388) ESTABLISHMENT OF A STANDARD THERMAL NEUTRON FLUX DENSITY AT THE BHABHA ATOMIC RESEARCH CENTRE. Shahani, M. G.; Sharma, D. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 22p. Dep. CFSTI (U. S. Sales Only).

A standard of thermal neutron flux density has been established for calibrating thermal neutron detectors. The moderating geometry consists of six $^{241}Am-Be$ (α,n) sources having total neutron emission rate of 6.6×10^6 n/sec imbedded in a graphite pile (163 cms × 122 cms × 152 cms). The thermal neutron flux density in a small air cavity (5 cms × 5 cms × 15 cms) at the center of the assembly has been absolutely measured in terms of ^{197}Au neutron capture cross section by $4\pi\beta - \gamma$ coincidence counting of high purity circular gold foils. Various corrections have been applied and sources of errors have been discussed. The Westcott flux density below cadmium cut-off energy at the center of the cavity is estimated to be 6454 ± 1.8 percent neutrons cm^{-2} sec^{-1}. The flux density in the central 5 cm region of the cavity has been found to be constant to better than 0.7 percent by $4\pi\beta$ counting of irradiated Mn–Ni foils. BARC flux standard has been directly compared with the standards maintained at the National Bureau of Standards, Washington; Electrotechnical Laboratory, Tokyo and Mendeleev Institute for Metrology, Leningrad, by exchanging irradiated gold foils. (auth)

45504 (BNWL–1051(Pt.3)) PACIFIC NORTHWEST LABORATORY ANNUAL REPORT FOR 1968 TO THE USAEC DIVISION OF BIOLOGY AND MEDICINE. VOLUME II. PHYSICAL SCIENCES. PART 3. INSTRUMENTATION. Porter, N. S.; Spear, W. G. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1969. Contract AT(45-1)-1830. 48p. Dep. CFSTI.

Separate abstracts were prepared for the 10 papers presented. (W.H.K.)

For abstracts of individual papers see: 45505–45510, 45574, 45575, 45601, and 46860.

45505 (BNWL–1051(Pt.3), pp 1-6) WOUND COUNTING WITH SOLID STATE DETECTORS. Swinth, K. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Lithium-drifted silicon detectors can be used to accurately measure (±0.2mm) the depth of typical point sources of plutonium, but distributed sources introduce large errors. The effects of line sources and surface contamination on depth estimation are presented. (auth)

45506 (BNWL–1051(Pt.3), pp 7-13) SUPPRESSION OF PARTIAL ENERGY DEPOSITION EVENTS IN A SOLID STATE DETECTOR. Swinth, K. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The suppression of the background continuum in solid-state detectors by anticoincidence and/or pulse-shape discrimination aids in the interpretation of spectra and enhances the peak to Compton ratio. Studies were performed with both ^{137}Cs and ^{59}Fe sources. For the ^{59}Fe source, an average reduction of 85% in the continuum resulted using a planar diode 110 mm^2 by 2.4 mm deep in an anticoincidence annulus of NaI(Tl). Both the distribution and the number of events rejected vary with the amplifier shaping time constants. (auth)

45507 (BNWL–1051(Pt.3), pp 13-17) DEVELOPMENT OF PULSE SHAPE DISCRIMINATION CIRCUITRY FOR COMPTON SUPPRESSION APPLICATIONS. Hoitink, N. C.; Philipp, L. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The proper use of pulse shape discrimination techniques aids suppression of the background continuum in spectra obtained using solid-state detectors. This suppression improves the interpretation of spectra and enhances the peak-to-Compton ratio. The development of pulse shape discrimination circuitry for use with or without anticoincidence techniques to investigate possible improvements in Compton suppression is described. (auth)

45508 (BNWL–1051(Pt.3), pp 18-21) FEASIBILITY OF USING CROSS-CORRELATION TECHNIQUES TO DETERMINE IN VIVO RADIONUCLIDE LOCATIONS. Morton, T. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Evaluation of the theoretical and technical feasibility of using a proposed cross-correlation system to determine in vivo location and intensity of radionuclides indicated that the specific method used would not be able to locate distributed sources with the required accuracy. Both the theoretical and experimental considerations are described. (auth)

45509 (BNWL–1051(Pt.3), pp 22-5) MINIATURE IMPLANTABLE HIGH VOLTAGE SUPPLY. Sheen, E. M.; Wilbur, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The described compact voltage supply for miniature G. M. tubes will permit the acquisition and telemetry of radionuclide uptake information and conventional physiological parametric data from experimental animals. The unit operates from a 2.7 V battery, requires 0.5 mA of current, and measures 1.5 cm diam by 2.3 cm long. (auth)

45510 (BNWL–1051(Pt.3), pp 30-5) RADON MONITORING. Swinth, K. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

An alpha scintillation detector system, built to monitor activity levels from 7 nCi/l to 150 nCi/l for monitoring radon in an experimental exposure facility is described. (auth)

45511 (FEI–143) FAST IONIZING FISSION CHAMBER. Kononov, V. N.; Metlev, A. A.; Poletaev, E. D.; Prokopets, Yu. S. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR [Obninsk]. Fiziko-Energeticheskii Institut). 1968. 11p. (In Russian). Dep. CFSTI (U. S. Sales Only).

A fast pulse fission chamber has been designed which permits registering with high efficiency fission fragments in the presence of a large background of alpha particles. Increased speed of action of the chamber was achieved as a result of direct use of current pulses forming in the chamber during the registration of charged particles and subsequent amplification of their discrimination by means of pulsed broad-band current devices. The chamber, containing 75 mg of ^{239}Pu (1.7×10^8 alpha-particles/second) has an efficiency of about 75%. The low intensity of the pulse front permits using the detector in experiments with nanosecond resolution. (tr-auth)

45512 (NYO–3246-TA-5) RESEARCH ON AVALANCHE TYPE SEMICONDUCTOR RADIATION DETECTORS. Semiannual Report, January–June 1969. Huth, Gerald C.; Locker, Robert J.; Hewka, Peter V.; Gelezunas, Vincent L. (General Electric Co., Philadelphia, Pa. Missile and Space Div.). July 1969. 66p. Dep. CFSTI.

Research to minimize the resistivity non-uniformity and thus to achieve high average gain with low gain spread, and good energy resolution is described. Avalanche detector applications can then be extended from nuclear radiation and photon counting to high-resolution spectroscopy. Also, a summary of the present level of knowledge and understanding of the performance and characteristics of the avalanche detector–tunnel diode circuit configuration, and of the underlying physical processes which determine this performance is presented. Included in this review is a brief summary of avalanche detector characteristics and physical properties, with emphasis on those aspects which affect circuit performance. (W.H.K.)

45513 (TID–25196) SPARK COUNTER NEUTRON DETECTOR FOR HIGH-TEMPERATURE APPLICATIONS. Final Report. Eichholz, Geoffrey G. (Georgia Inst. of Tech., Atlanta). June 1969. Contract AT(40-1)-3563. 56p. Dep. CFSTI.

Spark counters of the corrugated electrode type were designed and tested for use as neutron detectors in high neutron fluxes and at high temperatures. These detectors consist of a gas-filled coaxial assembly, in which circular ridges, acting as spark gap electrodes with the cylindrical outer container, are interleaved with boron-containing disks, which act as neutron converters by producing alpha particles by the $^{10}B(n,\alpha)^7Li$ reaction. These alpha particles trigger a spark across the gap, producing a large current pulse that is readily detected and counted. With argon or helium gas fillings, such counters were operated at temperatures up to 1076°F at which point the leakage currents across the ceramic insulator seals became excessive. The counters were tested in a wide range of neutron fluxes, up to 6×10^{10} n/cm^2 sec, and gamma-ray fields, up to 2×10^5 R/hr. The counters were found to have a linear response in neutron fluxes up to 6×10^8 n/cm^2 sec in the presence of gamma-ray fields of the order of 10^4 R/hr. Above that level the response became increasingly nonlinear as gas ionization due to primary and secondary gamma-rays became significant and ultimately suppressed the spark mechanism at

fluxes of the order of 3×10^{10} n/cm^2 sec. Attempts to extend the range of high flux response significantly by variations in gas pressure have not been successful. The detector sensitivity at low and medium fluxes is of the order of 10^{-8} counts/neutron and can be varied by increasing or decreasing the number of converter disks. (auth)

45514 CONTRIBUTION TO THE OPTIMIZATION OF WINDOW IONIZATION CHAMBERS. Oppelt, Jiri. Jad. Energ., 15: 259-66(Aug. 1969). (In German).

Calculations for gas pressure vs thickness of ionization chamber windows are presented for various window materials to obtain optimum ionization. (tr-auth)

45515 PULSED METHOD FOR DETERMINING ELECTRON MIGRATION IN ARGON. Asylbaev, U. Kh.; Isabaev, A. A.; Popova, V. D. (Kazakh State Univ., Alma-Ata, USSR). pp 187-9 of Voprosy Obshchei i Prikladnoi Fiziki. Alma-Ata, USSR, Izdatel'stvo Nauka Kazakhskoi SSR, 1969. (In Russian).

From 1st Kazakh Republic Conference on General and Applied Physics, Alma-Ata, USSR. See CONF-670556.

A new method was suggested for recording the initial electron motion in an ionization chamber. The initial time is assigned by the pulse produced during α-particle passage through a plastic scintillator. (R.V.J.)

45516 APPLICATION OF A SLOW-SCINTILLATION COMPONENT OF STILBENE IN DOSIMETRY OF MIXED RADIATION. Pszona, Stanislaw (Inst. of Nuclear Research, Swierk, Poland). Nukleonika, 14: 205-11(1969).

A circuit for selection of the slow-scintillation component of organic scintillators is described. A linear relation between the amplitude of the slow-scintillation component of stilbene and the energy of recoil protons within the range 1.2 – 14 MeV was found. The results of application of the slow-scintillation component of stilbene to dose distribution in LET_∞ measurement of mixed radiation are reported. (auth)

45517 ON THE POSSIBILITY OF MEASURING THE QUALITY FACTOR QF OF MIXED RADIATION USING A LIQUID-FILLED IONIZATION CHAMBER. Terlecki, Jozef (Danzig Academy of Medicine). Nukleonika, 14: 165-73(1969). (In Polish).

The quality factor QF of mixed radiation has been measured so far by means of a recombination method, in which a high-pressure gas-filled ionization chamber is used. It is proposed to replace a part of such a chamber, working under the conditions of column recombination, by a liquid-filled ionization chamber. In this way the advantages of both these chambers are achieved, and the faults of the gas-filled chamber are eliminated. (auth)

45518 RADIOACTIVE SCAN IMAGING. Hayt, David B. Image Dyn. Sci. Med., 4: 15-18(Mar.-Apr. 1969).

Radioisotope imaging systems, both moving and stationary, used in medicine are reviewed. The radioactive image of an organ is recorded photographically with both the scanner and camera imaging system. How the recorded data may be manipulated for processing to make it more interpretable is explained. Contrast between different count rate levels may be enhanced by the use of color recording directly from a scanning system by means of a multi-colored typewriter ribbon-type print-out with a tapper, or a color oscilloscope recording system. The raw data, as recorded photographically from a stationary imaging system such as the γ camera, may be converted from a black and white photograph to a color presentation by means of color television densitometry. A color television system for image scanning is described. (BBB)

45519 SELECTIVE PHOTON MODELING OF BOTH THE ELECTRON/HOLE-INDUCED AND THE EXCITON-INDUCED SCINTILLATION MECHANISMS IN NaI–Tl AND KI–Tl CRYSTALS. Denks, V. P.; Lushchik, Ch. B.; So'ovik, T. A. (Inst. for Physics and Astronomy, Tartu). Sov. Phys.-Solid State (Engl. Transl.), 11: 32-6(July 1969).

Translated from Fiz. Tverd. Tela, 11: 44-9(Jan. 1969).

The excitation spectra of photoscintillation by excitation with spark discharges of approximately 10^{-7} sec duration were studied in inorganic NaI:Tl and KI:Tl scintillators. Microsecond flashes emitted from Tl^+ centers were observed from pulse-induced generation of excitons and electron/hole pairs. Application of electric fields of about 10^5 V·cm^{-1} reduces the intensity of electron/hole-induced photoscintillation in NaI:Tl and KI:Tl crystals but does not reduce the exciton-induced photoscintillation in KI:Tl. In the case of KI:Tl, a reduction of the photoscintillation by a field could be observed when the Tl^+ centers had been transferred into the S or D states by excitation. The modern ideas on the exciton-induced and electron/hole-induced excitation mechanism of Tl^+ centers in scintillators are formulated in a more precise form. (auth)

45520 RADIATION DETECTION USING THE PARALLEL CHANNEL ELECTRON MULTIPLIER. Koyama, Masaki (Musashi Inst. of Tech., Kawasaki, Japan). Radioisotopes (Tokyo), 18: 345-9(Sept. 1969). (In Japanese).

The performance of a windowless continuous channel electron multiplier which utilizes a strip of semiconductor material (Si) for detection of some kind of radiation (α, β, γ) is described. The principle of the detector operation is the cascade reflection of the secondary electron multiplication between the two continuous silicon resistance strips. The silicon strips of the dynode obtained the resistivity of 10^6 to 10^7 Ω/cm by reactor irradiation. A current gain of 10^9 can be realized with the detector for an overall voltage of approximately 3 kV. The background counting rate of the detector, at room temperature and in typical operation is less than 1 count/hr for the pulses whose voltage, height is over 0.5 mV across the load resistance. (auth)

45521 RECORDING DEVICE FOR A RADIATION DETECTOR. Yuasa, Mitsuo (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-14469. June 19, 1969. Filed Nov. 20, 1965.

A design is given of a recording device for detecting a lesion by means of radiation penetration through the body from an injected radioisotope. The device is used for winding and unwinding a paper tape, which is dotted according to the quantity of penetrating radiation. The method enables the automatic winding and rewinding of the tape until the tape has been dotted to its capacity. The recording device consists of two plates, a drum wound with tape within the two plates, a drum to wind the tape above the first drum, and equipment for winding and rewinding tape on the drums. The design includes equipment to dot the tape at the bottom and move the frame in a horizontal direction. A motor and gears operate the drum in either direction. (NSA of Japan)

45522 PHOTOGRAPHIC PROCESSING OF NUCLEAR EMULSIONS. Bogomolov, K. S.; Krestovnikova, T. I.; Uvarova, V. M. Zh. Nauk Prikl. Fotogr. Kinematogr., 14: 295-303(July-Aug. 1969). (In Russian).

A brief review is given on published data covering photographic treatment of nuclear emulsions including the first steps of treating and developing the layers, neamidol developers, and special methods and chemicals for speedy development. (98 references.)(R.V.J.)

45523 GAS THRESHOLD CHERENKOV COUNTERS FOR SEPARATION OF PARTICLES IN THE BUNCHED BEAM FROM THE IHEP PROTON SYNCHROTRON. Donskov, S. V.; Kachanov, V. A.; Kut'in, V. M.; Petrukhin, A. I.; Prokoshkin, Yu. D.; Razuvaev, E. A.; Shuvalov, R. S. (Inst. of High Energy Physics, Serpukhov, USSR). Prib. Tekh. Eksp., No. 3, 60-4(May-June 1969). (In Russian).

A gas threshold Cherenkov counter was described for discrimination of particles in the bunched beam of the IHEP 76-GeV proton synchrotron. The counter was constructed on the bases of standard glass pipes. For the efficient recording of Cherenkov radiation quartz optics were used. The counter possesses high resolution as far as rates (threshold index curve $\delta = 9 \times 10^{-6}$), that permits discrimination of π and K mesons in bunches with momentum up to 60 GeV. (tr-auth)

45524 ELECTRONIC EQUIPMENT OF A FOUR-CHANNEL TELESCOPE OF SCINTILLATION COUNTERS. Antuf'ev, Yu. P.; Chechetenko, V. F. (Physical-Technical Inst. of Low Temperatures, Kharkov). Prib. Tekh. Eksp., No. 3, 98-101(May-June 1969). (In Russian).

The electronic equipment associated with a four-channel scintillation telescope for use with a 2-GeV electron accelerator was described. Diagrams were given for fast discriminator, coincidence circuits, and a linear gate. (tr-auth)

45525 LOGARITHMIC PULSE-HEIGHT CONVERTER. Stepanov, V. I. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 3, 115-18(May-June 1969). (In Russian).

A simple logarithmic pulse height converter was described for recording of pulses from scintillation detectors. The dynamic range of the converter is $\sim 8 \times 10^4$ with an accuracy of about 10%. The logarithmic conversion is realized with an oscillating circuit. The transformer has current input. The possibility of expanding the dynamic range up to 10^6 was examined. (tr-auth)

45526 COMPLETE ABSORPTION COUNTER OF THE SANDWICH TYPE. Golubnichii, P. I.; Onuchin, A. P. (Inst. of Nuclear Physics, Novosibirsk, USSR). Prib. Tekh. Eksp., No. 3, 74-7(May-June 1969). (In Russian).

A complete absorption counter with alternate plates of lead and scintillators was described. Calibration was carried out by monochromatic photons in the energy range 70 to 127 MeV. The relation between energy resolution and the total thickness of the counter and thicknesses of the lead and scintillators was given. (tr-auth)

45527 CHERENKOV THRESHOLD COUNTERS WITH A THIN RADIATOR. Kuznetsov, V. M.; Onisko, A. D.; Stukov, O. I.

(Tomsk Polytechnic Inst., USSR). Prib. Tekh. Eksp., No. 3, 65-6(May-June 1969). (In Russian).

A threshold Cherenkov counter with a thin Plexiglas radiator was studied. A straight light pipe with cuts down the sides permits efficient light collection. (tr-auth)

45528 PLASTIC SCINTILLATORS WITH INCREASED TRANSPARENCY. Gunder, O. A.; Malinovskaya, S. A.; Daich, A. R.; Teslya, L. G. (All-Union Scientific Research Inst. of Monocrystals, Kharkov). Prib. Tekh. Eksp., No. 3, 66-9(May-June 1969). (In Russian).

The properties of plastic scintillators consisting of naphthalene and other luminescent materials were described. This transparency is two to three times above plastic scintillators consisting of polystyrene. The luminescence of the latter constitutes 70 to 100% greater than the naphthalene-based scintillator. The improvement of scintillation properties upon low-temperature polymerization was discovered. (tr-auth)

45529 SCINTILLATORS WITH INCOMPLETE OPTICAL CONTACT. Tsirlin, Yu. A.; Sokolovskaya, T. I.; Globus, M. E.; Mokhir, E. P. (All-Union Scientific Research Inst. of Monocrystals, Kharkov). Prib. Tekh. Eksp., No. 3, 70-3(May-June 1969). (In Russian).

A formula was obtained for calculation of the average light collection coefficient τ of scintillators with incomplete optical contact. The comparison of the calculated values with experiments on a liquid model give good agreement. Using this model the light collection contribution to resolution was determined. (tr-auth)

45530 CHAMBER FOR THE STUDY OF NUCLEAR REACTIONS. Lukashunas, N. I.; Semenchuk, G. G. (Inst. of Technical Physics, Leningrad). Prib. Tekh. Eksp., No. 3, 41-4(May-June 1969). (In Russian).

A chamber was described for carrying out experiments for determining energy and angular distributions of charged particles from nuclear reactions. Silicon surface-barrier detectors were used in the chamber. Several detectors can be used simultaneously in the chamber, the angular positions of which can be changed remotely. (tr-auth)

45531 THERMOSTATIC CONTROL OF WILSON CLOUD CHAMBERS FOR THE ACCURATE MEASUREMENT OF PULSES. Fetisov, I. N. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 3, 46-50(May-June 1969). (In Russian).

A system for thermostatic control of a Wilson cloud chamber with a 260 l volume and operating in a magnetic field is described. The temperature of the chamber is maintained within several hundredths of a degree upon changes in the temperature of the air and the magnet of 5 to 10°C. (tr-auth)

45532 ACTIVE MAGNETIC SHIELDING OF PHOTOMULTIPLIERS. Lavoie, Louis; Winston, Roland (Univ. of Chicago). Rev. Sci. Instrum. 40: 1350-1(Oct. 1969).

Several different buckling field coils ranging in length from 2 to 10 cm^3 were constructed for generation of a counter B field in the cathode area of a photomultiplier tube in order to maintain the efficiency of the photomultiplier tube of a Cherenkov counter used in an intense magnetic field. (B.G.D.)

45533 ON THE OPERATION OF GEIGER COUNTERS WITH REVERSED POTENTIAL DISTRIBUTION. Sastri, R. C.; Chatterjee, S. D. (Jadavpur Univ., Calcutta). Indian J. Phys., 42: 696-708(Dec. 1968).

An account of the studies on the operation of Geiger counters with reversed potential distribution and the effect of heating the axial wire is given. Using a typical set of self-quenching, nonselfquenching and low voltage counters, variations of the parameters including pulse-size, plateau, dead-time and rise-time associated with counters under different modes of operation are presented. The discharge mechanism of self-quenching counters operated with potentials reversed is discussed in some detail. It is suggested that a radial spread of discharge takes place in the reversed operation of the counter instead of a lengthwise spread associated with normal counters. (auth)

Nuclear Spectroscopic Instrumentation

Refer also to abstracts 45418, 45728, 46862, 46940, and 47244.

45534 (CNM-R-2(Vol.2), pp 879-98) NEUTRON CRYSTAL SPECTROMETER FOR MATERIAL RESEARCH. Gavin, D. A. (Knolls Atomic Power Lab., Schenectady, N. Y.).

A single crystal lead monochromator was used for measurements at low neutron energies (0.03 to 0.10 eV) and a single crystal beryllium monochromator was used for measurements at 0.1 to 1.0 eV. Neutron transmission measurements and the energy resolution of the spectrometer are discussed. The methods and data for transmission analysis of various reactor materials are given. (W.H.K.)

45535 (COO-535-599) DESIGN AND PERFORMANCE OF A TRANSPORT SOLENOID-Si(Li) DETECTOR CONVERSION ELECTRON SPECTROMETER FOR ON-LINE USE WITH ACCELERATORS. Klank, B.; Ristinen, R. A. (Colorado Univ., Boulder). Aug. 1969. Contract AT(11-1)-535. 18p. (CONF-690818-1). Dep. CFSTI.

From International Conference on Radioactivity in Nuclear Spectroscopy, Nashville, Tenn.

The design and performance of an internal conversion electron spectrometer incorporating a solenoidal magnetic field along the target-detector axis for transporting electrons from a target placed in an accelerator beam to a cooled lithium-drifted silicon detector are described. An energy resolution of approximately 3 keV fwhm was obtained for electron lines over a wide range of energies. (W.H.K.)

45536 CONTINUOUS METHOD FOR THE MEASUREMENT OF NUCLEAR CROSS SECTIONS. Ghose, A. M. (Bose Inst., Calcutta). Sci. Cult. (Calcutta), 35: 67-8(Feb. 1969).

The sample under study is moved uniformly and continuously in a closed path. The irradiation takes place at one port in the system while the counting takes place in one or more other ports using properly shielded detectors. The activity equations are presented. (W.H.K.)

45537 A POSSIBLE METHOD FOR MEASURING THE FISSION-FRAGMENT ENERGY BY MEANS OF SOLID-STATE DETECTORS. Solov'ev, S. M.; Eismont, V. P. (Radium Inst., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 116-19 (Jan. 1969). (In Russian).

Direct measurements of the energy of fission fragments on the basis of the length of the tracks in a detector is difficult, even when the mean energies of the fragments are markedly different. In order to solve this problem, the energy (free path) resolution of the fission fragments was determined in the external medium, using a specially designed chamber placed in the neutron beam and containing two ^{235}U targets prepared by the vacuum evaporation of UF_4. The fragments were recorded by 2 mica films; they entered the layer under an angle of less than 30° with respect to the normal. The chamber contained dry air at a pressure of 360 mm of Hg. After an exposure of four hours, the mica was etched with concentrated hydrofluoric acid at 75°C. The tracks thus obtained consisted of rhombic depressions, the surface of which was independent of the energy. From the longitudinal distribution of the tracks, the integral distribution curve could be obtained. Examination of the curve indicated that there were two groups of free paths recorded. The graphic differentiation yielded a "double-humped" spectrum. Use of an empirical correlation between energy and free path allowed one to determine the mean energy of the light and heavy fragments. More reliable data were obtained from relative measurements by comparing the curves of the paths of fragments resulting from nuclear reactions. Reference measurements were made by radiochemical methods. (TTT)

45538 CALCULATION OF THE DEFORMATION OF AMPLITUDE SPECTRA AS A RESULT OF PULSE PILEUP. Pazman, A. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 3, 112-15(May-June 1969). (In Russian).

A method for calculation of the deformation of nuclear particle spectra as a result of pulse pileup was described. The method is based on pulse rejection and calculation of the dead time of the pulse analyzer. (tr-auth)

45539 UTILIZATION OF Ge(Li) GAMMA SPECTROMETERS FOR MEASUREMENT OF THE MASS DISTRIBUTION OF FISSION FRAGMENTS. Gvozdev, B. A.; Karamyan, S. A.; Mal'tseva, N. S.; Oganesyan, Yu. Ts.; Penionzhevich, Yu. E.; Sukhov, A. M.; Fefilov, B. V.; Sheglovskii, Z. (Joint Inst. for Nuclear Research, Dubna, USSR). Prib. Tekh. Eksp., No. 3, 33-6(May-June 1969). (In Russian).

A method was described for measurement of the mass distribution of fragments obtained from the fission of nuclei of heavy ions. It was shown that the group chemical isolation of elements with subsequent measurement of gamma spectra with Ge(Li) detectors gives results in the determination of the relative yield of isotopes of not worse than 15%. (tr-auth)

45540 CERTIFICATION OF BETA SOURCES ACCORDING TO SPECTRUM CHARACTERISTICS. Stepanov, E. K.; Tyutikov, N. V.; Ermilov, A. P. (All-Union Scientific Research Inst. for Physical Engineering and Radio Engineering Measurements, Moscow). Prib. Tekh. Eksp., No. 3, 37-41(May-June 1969). (In Russian).

A beta spectrometer utilizing a semiconductor detector for

certifying beta sources according to spectrum characteristics was briefly described. The energy resolution of the spectrometer was determined to be 4.3 keV (with reference to internal conversion electrons of ^{137}Cs). A control–calibration apparatus was fabricated containing a source of internal conversion electrons and a stable pulse generator for determining the main parameters of the spectrometer. (tr-auth)

45541 APPLICATION OF PULSED ELECTRIC FIELD FOR DISCRIMINATING IONIZED PARTICLES RECORDED IN NUCLEAR EMULSION. Labau, V. (Inst. of Atomic Physics, Rumania). Rev. Roum. Phys., 14: 429-35(1969). (In French).

Experiments on the application of an electric field for the discrimination of ionizing particles recorded in nuclear emulsions, resulting in the reactions of light elements (Li and B) with thermal neutrons, are presented. It is established that the degree of separation of the nuclear tracks increases with the intensity of the applied electric field. (tr-auth)

45542 METHOD AND MEANS FOR OBTAINING STEADY STATE OR MICROSECOND ENERGY SPECTRA IN A NEUTRON SPECTROMETER. Jeter, Thomas R.; Baldeschwieler, John D. (to Secretary of the Army). U. S. Patent 3,465,148. Filed Aug. 10, 1967.

The design is given of a neutron microsecond spectrometer and a method is described for the measurement of neutron energy from radioactive sources having time durations of several microseconds to infinite duration. A unique momentum analyzer and data storage system are employed to measure the energy of the recoil proton resulting from the radiation incident on a hydrogenous target. (Offic. Gaz.)

High Energy Physics Instrumentation

Refer also to abstracts 45577 46591, and 46644.

45543 (IFVE-SEF/SVM-68-78) THE SYSTEM OF CONNECTION OF THE SCINTILLATION HODOSCOPE IN LINE WITH THE COMPUTER "Minsk-22". Belotsvetov, A. E.; Belyaevskii, L. V.; Derevshchikov, A. A.; Zhil'chenkov, V. D.; Matulenko, Yu. A.; Mikhailov, Yu. V.; Nurushev, S. B.; Smirnov, E. V.; Solov'yanov, V. L. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1968. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The system connecting the scintillation hodoscope in-line with the computer "Minsk-22" is described. The results of the operation of this system in the 70 GeV proton beam are reported. (auth)

45544 (JINR-P2-4521) HIGH-ENERGY PARTICLE PATHS IN PHOTOEMULSION AND FREON. Barashenkov, V. S.; Rizvanova, R. M. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 5p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The dependence of the particle paths in emulsion and freon on the interaction cross section of an incident particle with a free nucleon is presented. (auth)

45545 (UCRL-19210) UNASSISTED ANALYSIS OF BUBBLE CHAMBER EVENTS. White, Howard S.; Hall, Dennis E. (California Univ., Berkeley. Lawrence Radiation Lab.). June 1969. Contract W-7405-eng-48. 21p. (CONF-690616-2). Dep. CFSTI. From Pattern Recognition Studies Seminar, New York.

Hardware and computer programs have been developed which allow bubble chamber events to be recognized and measured without manual assistance. All tracks in the three film images are digitized. Those track vertices which signify events are found, and the tracks are associated between views. Cost, precision, and reliability are favorable in comparison to manual methods. (auth)

45546 ROLE OF THE BUBBLE CHAMBER IN THE DISCOVERY OF NEW ELEMENTARY PARTICLES. Filthuth, H. (Univ., Heidelberg). Naturwissenschaften, 56: 158-64(Apr. 1969). (In German).

The construction and characteristics of bubble chambers are briefly summarized. The arrangement of elementary particles according to their interactions and of mesons and baryons according to their spin and parity is given to show the periodicity and indicate their composition from quarks. Bubble chamber experiments on the Ω hyperon, η meson and ω meson, Σ lepton decay, $\Sigma-\Lambda$ parity, and the neutrino experiment are summarized from the literature. (J.S.R.)

45547 DETERMINING THE PARAMETERS OF THE EXPONENTIAL ABSORPTION FROM THE ZENITH-ANGULAR DISTRIBUTION WITH COUNTER TELESCOPE DETECTION. Betev, B. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 65-83(1969). (In Russian).

The problem of determining the average free path for absorbtion and the absolute intensity of radiation of a given type in a given substance from data for the zenith-angular distribution in the case of counter telescope detection is solved. The maximum likelihood method is applied for the purpose. It is shown that the cosine approximation of the exponential law of absorbtion leads to data with smaller values for the absorbtion path. (auth)

45548 APPARATUS FOR RECORDING COSMIC ELECTRONS WITH ENERGIES OF 0,1 TO 1,5 GeV. Gal'per, A. M.; Grigorov, N. L.; Dmitrenko, V. V.; (and others). Prib. Tekh. Eksp., No. 3, 78-83(May-June 1969). (In Russian).

An apparatus was described for recording cosmic electrons with energies of 0.1 to 1.5 GeV at different altitudes. The main element of the apparatus is a shower spark chamber. The apparatus measures intensity, angular distribution, and energy spectra. The geometric factor of the apparatus is 13.5 cm^2/ster and the weight is ~35 kg. The apparatus was calibrated with a pulsed electron accelerator. (tr-auth)

45549 CALIBRATION OF dE/dx COUNTERS FOR COSMIC MUONS. Tonapetyan, S. G.; Konovalov, O. G.; Dorofeev, M. T.; Zybalov, A. A.; Derebchinskii, A. I. (Physical-Technical Inst. of Low Temperatures, Kharkov). Prib. Tekh. Eksp., No. 3, 83-5 (May-June 1969). (In Russian).

The amplitude distribution of pulses was obtained which were proportional to ionization losses of muons with energies of 100 to 120 MeV in dE/dx counters. The identification of muons was accomplished by their decay in foil spark chambers. (tr-auth)

45550 MEASUREMENT OF THE RELATIVISTIC INCREASE IN TRACK DENSITY IN PROPANE BUBBLE CHAMBERS. Ermilova, V. K.; Kotenko, L. P.; Merzon, G. I. (Inst. of Physics, Moscow). Prib. Tekh. Eksp., No. 3, 44-6(May-June 1969). (In Russian).

The relativistic increase in track density (g) was measured in a propane bubble chamber and can be described as $R = (g_{max} - g_{min})/g_{min}$. Experimental results did not conform with calculations according to the Bethe–Block formula, but conforms to the theory worked out by the authors, based on the threshold characteristics of the bubble formation process (threshold energy ≃1.0 keV). (tr-auth)

45551 THERMODYNAMIC AND PHYSICAL CHARACTERISTICS OF MIXTURES CONTAINING BROMOTRIFLUOROMETHANE AND PROPANE. Veselovskii, G. S.; Golubchikov, V. M.; Konoplev, N. S.; Khropov, M. S. (Inst. of Theoretical and Experimental Physics, Moscow). Prib. Tekh. Eksp., No. 3, 50-2 (May-June 1969). (In Russian).

Thermodynamic and physical properties of mixtures containing bromotrifluoromethane (CF_3Br) and propane (C_3H_8) were described. The equilibrium curve in the range 18 to 45°C was obtained. The densities of the mixtures were also obtained in the same temperature range. The values of radiation lengths were also obtained for these mixtures. (tr-auth)

45552 MEASUREMENT OF ENERGY SPECTRA OF ELECTRONS AND PHOTONS IN SPARK CHAMBERS. Bezus, V. A.; Gal'per, A. M.; Dmitrenko, V. V.; Kurochkin, A. V.; Luchkov, B. I.; Ozerov, Yu. V.; Shermanzon, E. M.; Yurkin, Yu. T. (Moscow Engineering-Physics Inst.). Prib. Tekh. Eksp., No. 3, 52-5 (May-June 1969). (In Russian).

A method was proposed for measurement of the energy spectra of electrons and photons, recorded in multilayer spark chambers utilizing the electron showers produced in the plates of the chambers. (tr-auth)

45553 DETERMINATION OF THE IONIZING POTENTIAL OF CHARGED PARTICLES IN SPARK CHAMBERS WITH SMALL SPACINGS. Agan'yants, A. O.; Leksin, G. A.; Tiunchik, V. M. Prib. Tekh. Eksp., No. 3, 55-8(May-June 1969). (In Russian).

A quantitative study of the relation between the ionizing potential of charged particles and the parameters of the photographic images of sparks corresponding to tracks in typical spark chambers. The possibility of measuring the specific-ionization of a charged particle by comparison of the parameters of the sparks representing the particle tracks and an artificial standard spark, simultaneously emerging in the same discharge interval, is described. (tr-auth)

45554 EXTENDED FLAT MICROPHONES FOR RECORDING SEPARATE SPARKS IN SPARK CHAMBERS. Ovchinnikov, B. M. (Inst. of Technical Physics, Leningrad). Prib. Tekh. Eksp., No. 3, 58-60(May-June 1969). (In Russian).

It was shown that flat, extended, electrostatic-type microphones

with amplifiers, which were previously proposed, permit recording of separate sparks by the difference of their distances from the microphones up to 6 mm. The possibility of utilizing these microphones in spark chambers was discussed. (tr-auth)

45555 VARIATION OF GRAIN DENSITY WITH SPECIFIC ENERGY LOSS IN NUCLEAR EMULSIONS. Sharma, A. P.; Gaur, R. K. (Kurukshetra Univ., India). Indian J. Phys., 42: 656-67 (Nov. 1968).

An attempt was made to explain the experimental curves showing the relation between grain density (ionization parameter) and specific energy loss in nuclear emulsions. A model based on the recombination of positive holes and electrons during the process of latent image formation has been suggested. The theoretical results agree satisfactorily with the experimental ones. (auth)

Radiation Dosimeters

Refer also to abstract 45594.

45556 (ORNL-tr-2199) ELECTRON ENERGY LOSSES IN MATERIAL: CALCULATING METHOD AND RESULTS. Bertel, E.; Joffre, H.; Pages, L.; Skiavenitis, L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Translated for Oak Ridge National Lab., Tenn., from report CEA-CONF-1087. 19p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 16160. (W.H.K.)

45557 (RD/B/N-1372) RESPONSE OF FINELY POWDERED THERMOLUMINESCENT LITHIUM FLUORIDE TO BETA RADIATION. Harvey, J. R.; Townsend, S. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). July 1969. 9p. Dep. CFSTI (U. S. Sales Only).

Experiments are described on the response of thermoluminescent LiF crystals to β radiation. Interpretation of the results of previous experiments with relatively large LiF crystals of around 100 μ dia was complicated because of penetration of β radiation through air gaps between individual crystals. The effect of this penetration was eliminated in the experiments by the use of very small LiF crystals of 2 to 3 μ dia. The results indicate that the light output from thermoluminescence LiF is proportional to the energy absorbed from sources of β radiation with end point energies in the range 0.167 MeV to 2.27 MeV. (auth)

45558 NEUTRON DOSIMETER. Druskina, L. S.; Pavlov, V. D.; Shaver, I. Kh. (Inst. of Physics, Riga). Latv. PSR Zinat. Akad. Vestis, Fiz. Teh. Zinat. Ser., No. 3, 37-41(1969). (In Russian).

The dosimeter is intended for measuring neutron dose rate. The range of the meter is in the range from thermal to 5 MeV. The meter scale is graduated in the units of limiting dose rate. A good coincidence of the curve characterizing the dependence of the meter sensitivity on the neutron energy with the curve of dosimetry has been achieved. (auth)

45559 RADIOPHOTOLUMINESCENCE DOSIMETRY BIBLIOGRAPHY. II. Becker, K. (Oak Ridge National Lab., Tenn.). Health Phys., 17: 631-6(Oct. 1969).

About 150 references are given to supplement the 253 references given in Part I (1966). Interesting recent developments in glass dosimetry are outlined. (UK)

45560 COUNTING OF BROKEN SULPHUR PELLETS AND INCREASING THE COUNTING EFFICIENCY OF SULPHUR PELLETS. Hankins, D. E. (Los Alamos Scientific Lab., N. Mex.). Health Phys., 17: 628-9(Oct. 1969).

Reference is made to personnel neutron dosimetry packets worn by personnel whose work takes them into areas where a criticality accident may occur. These packets consist of bare indium foil, a cadmium-covered indium foil, cadmium-covered copper foil, and a sulphur pellet, all encased in plastic wafer. It was found that many of the sulphur pellets become broken, sometimes into a number of small fragments. The counting procedure for the activated sulphur pellets was based on intact pellets. A counting technique for broken pellets is described which permits pieces of sulphur that can be removed from the PND packet to be accurately counted for ^{32}P activity. This technique increases the counting efficiency obtained from the sulphur pieces by a factor of ~2 greater than from intact pellets. Reproducibility is good.(UK)

45561 DECAY OF THE FLUORESCENCE OF GLASS DOSIMETERS EXCITED BY FLASHES OF ULTRAVIOLET LIGHT. Barthe, J. (Univ., Toulouse); Blanc, D.; Commanay, L.; Francois, H.; Teyssier, J. L. Radioprotection, 4: 109-20(1969). (In French).

The decay of the fluorescence of French glass dosimeters is studied using very short flashes of ultraviolet light coming from a laser. The measurement apparatus set up is described; starting from 500 ns after excitation, three decay time constants exist. The longest seems especially associated with the predose; the amplitudes of the other two increase much more rapidly as a function of the absorbed dose. These experiments enable one to consider the construction of reading devices more sensitive than those now being used, they also provide an original way to study the structure of such fluorescent media. (auth)

45562 DENSITY DISCRIMINATOR FOR USE IN RADIATION DOSIMETRY BY PHOTOGRAPHIC FILM. Cliff, K. D. (Radiological Protection Service, Sutton, Eng.). J. Phys., E (London), 2: 867-70(Oct. 1969).

A simple and reliable optical densitometer is described which possesses a high discrimination sensitivity and low drift. (auth) (UK)

45563 DOSIMETRIC PROPERTIES OF CaF_2:Dy. Binder, W.; Cameron, J. R. (Univ. of Winsconsin, Madison). Contract AT(11-1)-1105. Health Phys., 17: 613-18(Oct. 1969).

The general dosimetric properties of CaF_2:Dy (TLD-200) were investigated. Studies were carried out on 8 different batches. Results are reported on the last five batches which showed quite uniform characteristics. The glow curve structure and peak temperatures are given. The TL response was studied up to 10^6 R. The relative heights of the peaks in the glow curve changed with the exposure level and radiation quality. The TL-emission spectrum had peaks at 4600 Å, 4835 Å, and 5765 Å. Depending on the readout system TLD-200 was found to be 15 to 30 times more sensitive than TLD-100 on an integrated TL basis. Some annealing characteristics are given and the stability is discussed. TLD-200 shows energy dependence, which was studied from 20 keV effective to 1250 keV effective. (auth)(UK)

Radiometric Instruments

45564 NEUTRON METHOD FOR MEASURING HUMIDITY OF CASTING MIXTURES. Kravchuk, Yu. N.; Nadykto, B. T.; Gel'bshtein, Ya. I. (Pavlodar Industrial Inst., USSR). pp 272-3 of Voprosy Obshchei i Prikladnoi Fiziki. Alma-Ata, USSR, Izdatel'stvo Nauka Kazakhskoi SSR, 1969. (In Russian).

From 1st Kazakh Republic Conference on General and Applied Physics, Alma-Ata, USSR. See CONF-670556.

A neutron device was constructed for measuring the moisture of molded mixtures during the operation process. The neutron source consisted of a Pu-Be powder mixture with activity of 10^5 neutrons/sec. The scale was graduated in percentage of relative humidity. Sensitivity of the instrument is 0.1%. (R.V.J.)

45565 NUCLEAR METHOD FOR DETECTING SMALL VARIATIONS IN DENSITY WITHIN SOIL SPECIMENS. Shackel, B. (New South Wales Univ., Kensington, Australia). Aust. Road Res., No. 3, 12-34(Mar. 1969).

A method to measure variations in density within small soil or bituminous concrete specimens is outlined. Changes in density are determined by observing the attenuation of a beam of gamma radiation transmitted through the specimen. The equipment is described and statistical requirements and other factors affecting the accuracy of radiation measurements are discussed. Some experiments designed to compare the uniformity achieved by different methods of laboratory compaction are reported. (Australia)

45566 A NEW DESIGN PRINCIPLE FOR NEUTRON SOIL MOISTURE GAGES: THE "WALLINGFORD" NEUTRON PROBE. Bell, J. P. (Inst. of Hydrology, Wallingford, Eng.). Soil Sci., 108: 160-4(Sept. 1969).

The neutron moisture gage consists of the probe, transport shield, and cable. The probe contains the source, slow neutron detector, and circuitry which in previous designs was housed in the scaler. The slow neutron detector is a standard, 2.5 cm dia BF_3 counter. The source is 50 mCi of Am-Be. The electronic assembly and BF_3 counter may be withdrawn as a unit from the probe. The mean sensitivity of the probe is about 850 cps per unit moisture volume. (J.C.W.)

45567 RADIOMETRIC INSTRUMENT FOR THE CONTINUOUS PRODUCTION CONTROL OF BLAST-FURNACE DUST. Holzhey, Joachim; Demmrich, Horst (VEB Bergbau- und Huettenkombinat Albert Funk, Freiberg, Ger.). Neue Huette, 14: 198-201(Apr. 1969). (In German).

An instrument for the continuous measurement of blast-furnace dust was designed on the principle of radiation absorption. The construction and operation of the instrument is described, and results obtained under practical use of the instrument are reported. (J.S.R.)

45568 EXAMPLES OF APPLICATIONS OF DENSITY GAGES IN PIPES IN PRODUCTION UNITS. Loverdo, A. Bull. Inform. A.T.E.N. (Ass. Tech. Energ. Nucl.), Suppl., No. 76, 6-10(Mar.-Apr. 1969). (In French).

The principle of the operation of density gages using γ radiation is described, and the typical construction of these gages is outlined. Examples are given of the use of density gages in the industrial production of synthetic rubber and organic synthetics and in industrial thermal cracking. (J.S.R.)

Miscellaneous Instruments and Components

Refer also to abstracts 45504, 45543, 45983, 46824, and 47230.

45569 (AI-AEC-12802) TRANSIT TIME FLOWMETER EMPLOYING NOISE ANALYSIS TECHNIQUES. PART 1. WATER LOOP TESTS. Randall, R. L. (Atomics International, Canoga Park, Calif.). [1969]. Contract AT(04-3)-701. 117p. Dep. CFSTI.

Recent improvements in commercially available cross correlation measurement equipment have led to the development of a Transit Time Flowmeter for use in calibration of, or as an alternative to, conventional methods for flow measurement in liquid metal. The technique is based on detection of thermal eddies at two points separated a known distance in a flowing stream and measurement of the average transit time of the fluid between the sensors by cross correlation. Detailed descriptions are presented of the technique, instrumentation, and results of tests in a water loop. Future tests will include tests in 1200°F sodium. (auth)

45570 (AI-AEC-Memo-12848) SYSTEMS QUALITY SODIUM LOOP: OXYGEN METER CALIBRATION. Murbach, E. W.; Heath, N. W. (Atomics International, Canoga Park, Calif.). May 27, 1969. 11p. Dep. CFSTI.

An experiment to calibrate the electrochemical oxygen meter installed in the systems quality sodium loop is described. The cold trap was valved out of the loop and three injections of oxygen were made by addition through the cover gas. The oxygen was rapidly dissolved by the sodium as shown by a decrease in the oxygen meter output. The plugging meter was operated in the oscillating mode to estimate saturation temperatures of the dissolved oxygen. Several samples were taken for chemical analysis. The equation $E = 1.174 - 0.0545 \log C$ where E is in volts and C is wppm oxygen, was developed from the experimental results. (auth)

45571 (ANL-7520(Pt.1), pp 233-53) IMPURITY MONITORING IN A LARGE SODIUM TEST LOOP. Meyers, James E.; Hunter, Raymond A. (Atomic Power Development Associates, Inc., Detroit, Mich.).

The quantitative evaluation of the rhometer, oxygen meter, cover-gas chromatograph, plugging meter, and bypass freeze-tube sampler as means of monitoring sodium impurities in APDA's sodium technology loop is discussed. (C.E.S.)

45572 (ANL-7520(Pt.1), pp 254-61) ENGINEERING DEVELOPMENT AND PERFORMANCE OF THE UNC CARBON METER. Caplinger, Wayne H.; Stern, George (United Nuclear Corp., Elmsford, N. Y.).

A diffusion-type carbon meter has been developed for the measurement of carburizing potential in sodium. It reads continuously, has a rapid response, is reproducible, rugged, and possesses a long life. The range of carburizing potentials that the meter can measure extends from near unit carbon activity down to below the activity for carbon normally present in Type 304 stainless steel. Variations in sodium flow rate past the probe do not affect the carbon flux. A semi-automatic, self-contained instrument package was designed and built consisting of a probe, a side loop operating at 1400°F, a side-loop temperature-control console, and a gas-supply and analysis console. The instrument package can be fitted into pumped loops. Hydrogen leakage from the sensor will not be a serious contaminant in sizable sodium systems. (auth)

45573 (ANL-7520(Pt.1), pp 262-7) ELECTROCHEMICAL METER FOR HYDROGEN IN SODIUM. Holden, R. B.; Fuhrman, N. (United Nuclear Corp., Elmsford, N. Y.).

An on-line meter to monitor continuously the hydrogen activity of the sodium coolant in reactors such as the LMFBR is described. The meter has two basic applications: (1) to determine the hydrogen impurity level in the primary loop, and (2) to serve as an indicator of water leakage into the secondary sodium system. The meter utilizes a hydrogen-sensor concept which is essentially an electrochemical concentration cell. It consists of a cylindrical reference electrode, within a concentric tube of a metal resistant to sodium, which serves as the sensing electrode. These electrodes are electrically insulated from each other except through their annulus, which contains an ionic hydride-bearing electrolyte such as, for example, LiH dissolved in LiCl–KCl eutectic. The active ends of the electrodes consist of thin metal septa, which permit transport of hydrogen, but separate the reference material and the sodium from the electrolyte. The reference may be a two-phase solid mixture whose hydrogen pressure is determined solely by temperature, such as $Ca-CaH_2$, or a flowing gas having a constant partial pressure of hydrogen. The outer septum comes to equilibrium with the sodium so that the hydrogen activity is the same in both. The inner septum similarly acquires the hydrogen activity of the reference material. The result is an electrolytic cell whose overall cell reaction involves the transfer of hydrogen from the sodium to the reference. The actual transfer of hydrogen is substantially zero, because the measurement is potentiometric with extremely low current flow. (B.G.D.)

45574 (BNWL-1051(Pt.3), pp 35-7) CONTROL SYSTEM FOR IN VIVO NEUTRON ACTIVATION OF SHORT HALF-LIFE NUCLIDES. Sheen, E. M. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

An instrument to automatically correct for half-life decay during in vivo neutron activation experiments using human cadavers is described. The control system assures uniform activation by providing automatic compensation for half-life decay, controls to rotate the body 180° and other controls to stop the irradiation when the two activities equalize. Analog pulse rate techniques are utilized. (auth)

45575 (BNWL-1051(Pt.3), pp 38-43) SMOKING CONTROL UNIT FOR CANINES. Wilbur, R. L. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Uranium miners exposed to radon gas, radon daughters and uranium ore dust in the course of their work, often smoke as well. A study in progress hopes to determine the incidence of lung cancer from any or all of the contaminants and the correlation of one to another. An automatic nine-channel system capable of controlling the air-smoke ratios of 1–10 breaths of air to one breath of smoke filled air with beagle dogs is described. Each dog controls his smoke volume by demand regulation, thus preventing serious distress problems in sensitive animals. The nine-channel unit comprises the previously described three-channel unit extensively modified and a newly designed six-channel unit. (auth)

45576 (CEA-R-3407) DIRECT DIGITAL CONTROL OF FURNACES RADIATED IN NUCLEAR REACTORS. Joumard, Raymond (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). Apr. 1969. 225p. (In French). Dep. Thesis. Submitted to Grenoble Univ., France.

An experimental direct digital control system has been realized in the C.E.N.G., in order to verify that a computer makes easier the control of the experiments done in the nuclear reactors and to solve the theoretical and technical difficulties. The regulation is applied to thermal processes. The sampled data systems theory permits choosing an efficient and simple digital compensator, and establishing a diagram which gives the values of the correcting parameters (obtained by minimizing the difference between the output and the input when perturbations occur). The program executes, simultaneously, supervision and regulation. Complex possibilities of printing out measures and alarms existed. The computer works out an incremental correction which makes step motors to turn. The motors act on the heating organs. The theoretical values and answers have been confirmed. The accuracy was limited essentially by the input quantification (1/1000th). (auth)

45577 (COO-1018-1168) PARAMETRIC DESCRIPTION OF A SCAN-DISPLAY SYSTEM. Dunn, Lawrence A.; Goyal, Lakshmi N.; McCormick, Bruce H.; Tareski, Val G. (Illinois Univ., Urbana). Oct. 4, 1968; Revised Feb. 5, 1969. Contract AT(11-1)-1018. 71p. (CONF-690533-1). Dep. CFSTI.

From Spring Joint Computer Conference, Boston, Mass.

The parametric description of a general purpose Scan/Display System for image digitization and display is presented. Central to the system is the S-M-V Controller which can service either simultaneously or individually three distinct media: film, closed-circuit television and incrementally-driven CRT displays. An adjunct of the system is a Video Communications Net to provide both high and commercial resolution service to remote users. (auth)

45578 (DUN-SA-108) IRRADIATED FUEL EXAMINATION AND MEASUREMENT. Sowa, K. B. (Douglas United Nuclear, Inc., Richland, Wash.). Aug. 27, 1969. Contract AT(45-1)-1857. 11p. (CONF-690910-2). Dep. CFSTI.

From Symposium on Developments in Irradiation Testing Technology, Sandusky, Ohio.

Two methods for underwater dimensional measurement of irradiated fuel elements at Hanford are described including optical comparators and hydraulic gaging. (W.H.K.)

45579 (EGG-1183-3004) DEVELOPMENT OF AN ABSOLUTE DISPLACEMENT TRANSDUCER. Final Report. Richter, J. M. (EG and G, Inc., Albuquerque, N. Mex.). July 1969. Contract AT(29-1)-1183. 25p. Dep. CFSTI.

A prototype model of an absolute vertical displacement transducer for use in earth motion measurements has been constructed and tested. The transducer consists of an internal reference mass which is counterbalanced against gravity by a constant-force Negator spring motor. The prototype transducer has a peak-to-peak displacement range of 15 inches, a resolution of 0.167 percent of full scale or 0.025 inch, a sensitivity of 0.0127 volts/volt-inch, and is linear within ±1 percent of full scale. The 3-dB low-frequency cutoff for a sinusoidal displacement of a 1.5-inch amplitude is 0.35 Hz. However, for frequencies below 2 Hz, there is an amplification of the output and a phase difference between the input and the output. Factors affecting the low- and high-frequency cutoffs, as well as other factors affecting the overall system response, are discussed. (auth)

45580 (KFK-897) DATA-LOG: A DEVICE FOR CONTROL OF THE LOGIC FUNCTION IN THE DATA SYSTEM. Brueckmann, H.; Fluck, P.; Matthaey, H.; Schaenzler, L. (Kernforschungszentrum, Karlsruhe (West Germany). Institut fuer Experimentelle Kernphysik). Dec. 1968. 26p. (In German). Dep. CFSTI (U. S. Sales Only).

DATA-LOG is the central unit of the data acquisition system DATA. The system accepts simultaneously up to five independent analog signals. These signals might be derived from a single event in nuclear reaction studies. The five independent parameters may for example represent information on energy loss, time-of-flight or dE/dx for a single coincidence event. Five ADC's integrated into DATA digitalize the information with an accuracy of 12 bit/parameter. The whole digital information (up to 48 bit) is transferred to a CDC-3100 computer. The unit DATA-LOG is responsible for the control of the data flow between experiment and computer and directs a selectable part of the information to a separate memory or multichannel analyzer for monitoring purposes. DATA-LOG generates and accepts all logical signals being necessary for the common-operation of the five ADC's, the memory, and the computer. The theory of operation and the electronic design of DATA-LOG is discussed in detail. The DATA system was designed for nuclear reaction studies and is operating at the Karlsruhe Isochronous Cyclotron. (tr-auth)

45581 (LA-4182) THE $\sqrt{N}$ FANOUT AND THE AVALANCHE PULSER. Fullwood, R. R.; Gallegos, J. E. (Los Alamos Scientific Lab., N. Mex.). May 19, 1969. Contract W-7405-eng-36. 6p. Dep. CFSTI.

A lossless fanout would have a voltage attenuation of $\sqrt{N}$, where N is the number of outputs. A prototype 64-N fanout that has a loss of 8%, a maximum-to-minimum output ratio of 1.4, and poorest output rise time of 20 nsec is constructed. The delay is 15 nsec, but the outputs are matched to 8 psec. Also, construction of a Cockcroft-Walton avalanche pulser that develops 300 V on a 50-Ω load using cheap epoxy transistors is described. The rise time and delay are 10 nsec, the jitter is less than 1 nsec, and the exponential decay time is 150 nsec. (auth)

45582 (NVO-40(Rev.2), pp 83-97) GROUND MOTION AND STRUCTURAL RESPONSE INSTRUMENTATION. King, Kenneth W. (Coast and Geodetic Survey, Las Vegas, Nev. [Special Projects Party]).

The Coast and Geodetic Survey Special Projects Party presently utilizes four major and four minor seismic systems in fulfilling their program objectives of measuring nuclear event caused ground motion, structural response, structural vibration, and seismic wave propagation studies. The major seismic instrumentation systems are described including the strain gage accelerometer, the C and GS strong motion accelerograph, the NGC-21 velocity seismometer, and the L-7 velocity seismometer. Instrument geographic locations are included. (W.H.K.)

45583 (NYO-3622-25) ULTRASONIC FLOWMETER FOR HIGH-TEMPERATURE OPERATION. Kartluke, Herbert (Aeroprojects Inc., West Chester, Pa.). July 1969. Contract AT(30-1)-3622. 70p. Dep. CFSTI.

An ultrasonic flowmeter, developed for use in a high-temperature reactor flow system, provided for transmission of an ultrasonic signal from a side-entry probe and reception by probes located upstream and downstream from the transmitter is described. Flow rate was determined by differences of relative phase angle of the received signals. The flowmeter was tested and calibrated at a temperature of 1200°F in a molten sodium test loop at Mine Safety Appliances Research Corporation. Satisfactory operation was demonstrated, with little scatter in the calibration data and without restriction of the flow channel. (auth)

45584 APPLIANCE FOR MEASURING INTRACEREBRAL (C. S. F.) PRESSURE AND CALCULATED SUBARACHNOID ADMINISTRATION OF RADIO-ACTIVE ISOTOPES. Lyass, F. M.; Maiorova, N. A. (Burdenko Inst. of Neurosurgery, Moscow). Byull. Eksp. Biol. Med., 68: No. 7, 118-20(July 1969). (In Russian).

A simple apparatus that prevents a marked increase of the cerebrospinal fluid pressure during subarachnoid administration of radioactive isotopes is described. (auth)

45585 OGO-V ION SPECTROMETER. Harris, Kent K.; Sharp, Gerald W. (Lockheed Palo Alto Research Lab., Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Geosci. Electron., GE-7: 93-8(Apr. 1969).

A description is given of the ion spectrometer aboard the Orbital Geophysical Observatory, OGO-V, an instrument for topside ionospheric and magnetospheric investigations. It is a versatile, very sensitive magnetic-focus ion spectrometer which measures the ionic abundance of masses 1, 4, and 16 in the upper ionosphere and exosphere, as well as the energy distribution of protons from 0 to 600 eV. The highly elliptical character of the OGO-V orbit makes it possible to obtain data on the height profiles of these ion concentrations in the topside ionosphere and hence to observe which ion species dominates at a given altitude and the altitude at which the dominant ion is changed. The long lifetime of the vehicle also makes it possible to see how these abundances and the associated transition levels change with time, solar activity, and geographic position. The ion spectrometer will also observe the character of the plasmapause and define its location with respect to geomagnetic coordinates. In the regions outside the magnetosphere the operation of the instrument changes character from an ion mass spectrometer to that of an ion energy spectrometer. The energy distributions of particles in the magnetosphere, the magnetosheath, and the solar wind regions are then obtained. The concentration profiles of O^+, He^+, and H^+ ions are obtained with excellent spatial resolution and with a sensitivity sufficient to measure less than 1 ion/cm^3. The dynamic range of the instrument is better than 8 orders of magnitude. These functions are accomplished with an absolute minimum of telemetry bandwidth. (BBB)

45586 A SWEEPING NEUTRAL AND POSITIVE ION MASS SPECTROMETER FOR ATMOSPHERIC COMPOSITION AT SATELLITE ALTITUDES. Hinton, Barry B.; Kistler, Roland D.; Leite, Richard J.; Mason, Conrad J. (Univ. of Michigan, Ann Arbor). IEEE (Inst. Elec. Electron. Eng.), Trans. Geosci. Electron., GE-7: 107-14(Apr. 1969).

The design described represents a first attempt to develop a sweeping mass spectrometer which performs both neutral-particle and positive-ion concentration measurements aboard an earth satellite. An open ion source design is utilized to adapt, with minimum degradation, both kinds of particles for the filtering action of the quadrupole field. Six linear ranges of sensitivity are provided to permit complete compositional analysis between altitudes of 300 and 1000 km. The mass range is 0 to 50 μ, and maximum sensitivities are 10^5 neutral particles/cm^3/output and 10 positive ions/cm^3/output. Neutral particle and positive ion measurements are made sequentially each requiring ~36 sec to complete using a sweep duration of ~6 sec. On OGO-IV this sweep duration provided a spatial resolution of 0.8 km/mass unit of sweep. A photograph of the complete flight spectrometer is shown. It occupies a volume of 0.01 m^3, weighs 3.8 kg, and requires 24 W average power input at a nominal voltage of 28 V. Preliminary results show that the spectrometer is operating within design specifications and with good signal-to-noise ratio. Acquisition of both neutral particle and positive ion data should greatly advance the understanding and selection of the most probable reactions occurring in the atmosphere. (BBB)

45587 MODIFICATION OF A FURNACE SOURCE OF IONS FOR THE MASS SPECTROMETER MI-1305. Gordienko, S. P. (Inst. of Materials Management Problems, Kiev). Prib. Tekh. Eksp., No. 3, 224-6(May-June 1969). (In Russian).

A modified furnace source of ions was described for the mass spectrometer MI-1305, which permits the study of the evaporation of refractory materials in the range 1200 to 2500°K by simultaneous measurement of the intensity of ion currents and controlling the temperature of the material. (tr-auth)

45588 MEASUREMENT OF THE RESOLVING TIME OF COINCIDENCE-ANTICOINCIDENCE CIRCUITS. Chechetenko, V. F. (Physical-Technical Inst. of Low Temperatures, Kharkov). Prib. Tekh. Eksp., No. 3, 111-12(May-June 1969). (In Russian).

An apparatus was described which permits direct measurement of the resolving time of coincidence-anticoincidence circuits in a short period of time. The accuracy of the measurements is 1% at a resolving time of ≥3 nanoseconds. (tr-auth)

45589 SIMULTANEOUS RECORDING OF SEVERAL COMPONENTS IN A MASS SPECTROMETER WITH A SINGLE-COLLECTOR MASS ANALYZER. Pushkina, M. A.; Slutskii, M. E. (Design and Construction Bureau for Analytical Instruments, Leningrad). Prib. Tekh. Eksp., No. 3, 160-3(May-June 1969). (In Russian).

A system for simultaneous recording of three mass peaks in a mass spectrometer with a rf single-collector mass analyzer is described. The system uses electronic commutation, which provides separation of signals according to three channels of measurement with subsequent recording on a three-channel recording apparatus. The commutation of the mass peaks in the mass analyzer is realized by a high-frequency resistance diode. The system is used in a mass spectrometer for analysis of N_2, O_2, and CO_2 in the process of respiration. (tr-auth)

45590 DETERMINATION OF THE TEMPERATURE COEFFICIENTS OF DYNODE SECONDARY EMISSION AND CATHODE YIELD OF PHOTOMULTIPLIER TUBES. Pertsev, A. N.; Soshin, L. D.; Tolkach, P. N. (Belorussian State Univ., Minsk). Prib. Tekh. Eksp., No. 3, 169-71(May-June 1969). (In Russian).

A method for studying the effects of temperature on the secondary emission of dynodes and the yield of photocathodes of photomultiplier tubes is discussed. (tr-auth)

45591 ACCURACY AND CHARGING SPEED IN PULSE STRETCHERS. PART 2. Casoli, P.; Manfredi, P. F. (Politecnico, Milan). Energ. Nucl. (Milan), 16: 487-99(Aug. 1969).

A careful analysis was developed with the aim of finding the best design and matching of the separate circuits in the feedback loop, as well as the theoretical limits of a peak stretcher. A linear theory and considerations referring to the saturated behavior (charging at nearly constant current), based upon some simplified models representing different peak stretchers are presented. Four circuits were realized with the support of theoretical conclusions. According to the exhaustive experimental tests which were carried out on the developed stretchers, they are believed to satisfy most of practical needs in this field. Moreover, the agreement between their actual behavior and the theoretical indications turns out to be satisfactory. (auth)

45592 NUCLEAR MAGNETIC RESONANCE SPECTROMETER. Ionaitis, G.; Misyunas, G.; Kimtis, L. (Vilnyus State Univ., USSR). Liet. Fiz. Rinkinys, Liet. TSR Mokslu Akad., Liet. TSR Aukst. Mokyklos, 8: 683-92(1968). (In Russian).

A nuclear resonance spectrometer for observing high resolution spectra of hydrogen and fluorine resonances at 22.98 MHz is described. The spectrometer is of simple design but its stability and resolving power is $2 \cdot 10^{-8}$ when using samples of diameter approximately 5 mm. An electromagnet with flux-stabilizer is used to provide the main magnetic field and a simple bridged T-spectrometer is used. (auth)

45593 HEXAPOLE ELECTROMAGNET FOR FOCUSING BUNCHED ELECTRONS IN THE ION SOURCE OF MASS SPECTROMETERS. Novitskii, V. V. Prib. Tekh. Eksp., No. 3, 226-7(May-June 1969). (In Russian).

The construction of an electromagnet with spatial transfer of the vector potential of the magnetic field for focusing an electron bunch in the ion source of a mass spectrometer is described. The electric regulation of the position of the bunch permits rapid location of its optimum position. The hexapole electromagnet is convenient for remote control of the mass spectrometer. (tr-auth)

45594 SPECTRAL AND DOSIMETRIC CHARACTERISTICS OF SOFT X RAYS FOR STUDIES IN RADIOBIOLOGY. Clark, B. C.; Gross, W. (Columbia Univ., New York). Contract AT(30-1)-2740. Radiology, 93: 139-45(July 1969).

A demountable x-ray generator was developed to investigate the radiobiological effects of soft x rays. This generator is capable of operating with high dc currents at relatively low potentials (e.g., up to 500 MA at 6 kV). It consists of a Pierce type electron gun and a water-cooled target. The use of the gun permits a large current even at an 11.5-cm target-cathode spacing. This large spacing is required to prevent deposition on the target of a significant amount of tungsten evaporated from the filamentary cathode. Such a deposit would change the target from the selected material to tungsten. The target is constructed from a hollow copper cylinder of square cross section. Each face of the cylinder forms one target and the target material is applied to the copper by vacuum evaporation. The design permits the use of each of the four different target materials without disturbing the vacuum. A thin composite window formed by a beryllium foil and a Mylar film isolates the high vacuum in the generator from a chamber filled with helium at one atmosphere. The x rays emerge from this chamber through a second Mylar film. The total inherent filtration is 0.0005 inch of beryllium and 0.0003 inch of Mylar. Results are reported from measurements of the characteristics of x-ray beams produced by this generator. A proportional counter was specially designed for measuring the x-ray energy distributions from the generator. (auth)

45595 SPECTROPHOTOMETRIC SYSTEM FOR TRANSIENT OBSERVATION OF SOLIDS UNDER PULSED ELECTRON IRRADIATION. Williams, R. T.; Fuller, R. G.; Kabler, M. N.; Ritz, V. H. (Naval Research Lab., Washington, D. C.). Rev. Sci. Instrum., 40: 1361-2(Oct. 1969).

A relatively simple apparatus for measuring the properties of transient optical absorption and emission bands in solids under pulsed irradiation is described. (B.G.D.)

45596 IONIZATION VACUUM GAUGE WITH X-RAY SHIELDING AND ION REFLECTING MEANS. Redhead, Paul Aveling (to Canadian Patents and Development Ltd.). U. S. Patent 3,465,189. Priority date Oct. 13, 1966, Canada.

A vacuum gauge is described of the gas ionization variety which has an accelerating grid cage for accelerating electrons which subsequently bombard and ionize gas molecules within a region substantially defined by the grid cage. The region is separated from a collecting electrode which collects the ionized molecules by a separation plate having a small hole through which the ionized molecules migrate. The plate assists in shielding the collecting electrode from the effects of soft x-rays produced by electron bombardment within the region. In proximity to the collecting electrode, a reflecting electrode is provided to focus the ionized molecules which migrate through the opening onto the collecting electrode. Because of the potential gradient between the reflecting and collecting electrodes, and their symmetrical relationship to the opening and the grid cage, desorbable ions are not focused on the collecting electrode. (Offic. Gaz.)

45597 COMMENT ON "CHANNELTRON FATIGUE AND EFFICIENCY FOR PROTONS AND ELECTRONS." Wolber, W. G.; Klettke, B. D.; Lintz, H. K. (Bendix Research Labs., Southfield, Mich.). Rev. Sci. Instrum., 40: 1364-5(Oct. 1969).

In a recent article, Egidi et al., (Rev. Sci. Instrum., 40: 88 (1969)) presented very interesting fatigue data on the behavior of type-4013 Bendix Channeltron single particle detectors subjected to continuous electron bombardment while in a vacuum of 10^{-6} torr. The additional data presented on electron and proton detection efficiencies are especially pertinent to experimenters considering employing these detectors in solar wind investigations. It is noted, however, that the fatigue data were obtained by operating the Channeltron electron multipliers at relatively high counting rates. In view of the results, it seems useful to point out that four types of loss in gain during Channeltron multiplier operation occurs and that care must be exercised in distinguishing between these losses when attempting to interpret data such as have been reported by Egidi et al. (auth)

45598 WIDE RANGE PULSE HEIGHT DISCRIMINATOR WITH LOW POWER DRAIN. Cancro, Ciro A.; Garrahan, Norman M. (Goddard Space Flight Center, Greenbelt, Md.). Rev. Sci. Instrum. 40: 1360-61(Oct. 1969).

A wide range pulse height discriminator for use in nuclear experiments on scientific satellites is described. The discriminator, with power drain in the milliwatt range, will be used in integral pulse height analyzers and in threshold detectors with adjustable threshold levels. (B.G.D.)

45599 SLIDING-SHAFT VACUUM LOCK FOR A MASS SPECTROMETER. Stoffels, J. J.; Langergren, C. R. (Battelle-Northwest, Richland, Wash.). Rev. Sci. Instrum., 40: 1288-90 (Oct. 1969).

A sliding-shaft type of vacuum lock for a mass spectrometer is described in which the sample carriage and pumping manifold are made entirely of sintered alumina (95% Al_2O_3). The hardness of this material effectively eliminates any problem of seizing due to entrance of foreign matter or gradual wear of the bearing surfaces. Components of the high voltage ion source are fully insulated when mounted directly on the carriage. The single ended design avoids the critical alignment required with two-manifold systems. (auth)

45600 QUARTZ WINDOW ASSEMBLY IN A SYSTEM FOR QUANTITATIVE DETERMINATION OF THE CONCENTRATION OF VAPOURS IN A CARRIER GAS, AND METHOD OF MAKING THE ASSEMBLY. Verheyden, Luc; Klein, Klaus; Cappelletti, Carlo (to EURATOM). British Patent 1,162,698. Aug. 27, 1969. Priority date Dec. 20, 1965, Germany.

A quartz window is described for use with a monitoring system such as might be used to monitor leakage from an organic-cooled

reactor coolant system. The window device is positioned in a duct heated to ~450°C through which passes a carrier gas containing the vapors that absorb uv light. The quartz window is held in a tube made of Fe–Ni–Co alloy, and the tube wall thickness diminishes from the suspended end to the free end. The free end of the tube is engaged by a clamping means consisting of a brass screw plug with a steel cup and a silver ring. The plug and spring press the holder tube onto the ring, which is mounted loosely between the shoulders on the tube and the duct wall. The entire clamping means engages the end of the holder tube in an axial direction of the duct wall and tends to increase the pressure by action of thermal expansion and by soldering the quartz window to the free end of the holder tube on an angular surface sloping conically to an angle between 10 and 20° to the plane normal to the principal axis of the tube. The system is particularly suited to monitoring leaking of terphenyls with a N_2 carrier gas. (B.L.M.)

Radiation Effects on Instruments and Instrument Components

45601 (BNWL–1051(Pt.3), pp 25–7) IRRADIATION EFFECTS ON CHARGE-MULTIPLYING DIODE DETECTORS. Hoitink, N. C. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The conclusions of a program to define the irradiation effects of ^{60}Co on passivated and nonpassivated avalanche diodes biased near breakdown are presented. The annual report for 1967 mentioned the experiments which are described in greater detail in a separate formal report. (auth)

45602 RADIATION INFLUENCE OF ELECTRONIC COMPONENTS IN SPACE FLIGHT. Baeuerlein, R.; Kobale, M. Int. Elektron. Rundsch., 23: 64–6(Mar. 1969). (In German).

Radiation damage to components and materials used in electronic equipment was studied with particle accelerators and a ^{60}Co source simulating the intensity and energy of space radiation. Doses are given for approximate onset of noticeable and marked changes in properties of metal wires and sheets; paper, styroflex, mica, ceramic, and electrolytic condensers; hf, varactor, tunnel, and Zener diodes; silicon rectifiers; Si p–n, Si n–p, Li-diffused Si, and thin-layer solar cells; NF, hf, and MOS transistors; normal and quartz glass; rubber; polyethylene; polystyrene; teflon; polyester; and epoxy and phenol resins. Data are given for optical properties of glasses. Insulator materials were studied in the absence of O_2. (TSS)

LIFE SCIENCES

Biochemistry, Physiology, and Molecular Biology

Refer also to abstract 45226.

Basic Processes

Refer also to abstracts 45220, 45830, and 47244.

45603 (AEC-tr-6982) DISTRIBUTION OF RADIOACTIVE ELEMENTS IN THE ANIMAL ORGANISM (^{210}Po, ^{228}Th, ^{239}Pu, AND ^{90}Sr). Atlas. Erleksova, E. V. Translation of Raspredelenie Nekotorykh Radioaktivnykh Elementov v Organizme Zhivotnykh (^{210}Po, ^{228}Th, ^{239}Pu i ^{90}Sr) Atlas, Medgiz, Moskva, 1960. 164p. (TT-69-55018; IPST-Cat.-5446). Dep. CFSTI.

Autoradiographic methods for the quantitative measurement of the distribution of ^{210}Po, ^{239}Pu, ^{90}Sr, and ^{228}Th in animal tissues (dogs, mice, rabbits, and rats) are described. Calculations are based on track counts or grain counts on autoradiograms. (85 references.) (C.H.)

45604 (ANL-7535, pp 37-9) THE EFFECT OF VARIOUS DOSE LEVELS AND SPECIFIC ACTIVITIES OF TRITIATED THYMIDINE IN TWO SPECIES OF HAMSTER. Reiskin, Allan B.; Sallese, Anthony R.; Kisieleski, Walter E.; Tyler, Sylvanus A.; Newlin, Janet E.; Fry, R. J. Michael (Argonne National Lab., Ill.).

The durations of DNA synthesis were determined for a number of different tissues; and with data obtained from grain counts and other determinations it should be possible to assess the importance of availability and precursor pools in the characteristics of tritium labeling in different tissues. Results showed that labeling index, the commonly used index of proliferative activity, is not affected by the range of doses and specific activities of ^{3}HTdR used. In different species, the problem is confounded by the added possibility of differences in metabolic pathways. (C.O.)

45605 (ANL-7535, pp 76-7) STUDIES ON THE CORNEAL EPITHELIUM. Fry, R. J. Michael; Weber, Charlotte L.; Newlin, Janet E. (Argonne National Lab., Ill.).

Because of its remarkable reparative capability, the corneal epithelium was studied for effects of radiation of different LET and exposure patterns on response to cell loss. The studies reported are basic studies preliminary to study of radiation effects. Tritiated thymidine labeling showed a significant rise in the percent labeled mitoses only when the label was given parenterally to the mice. Results over a 120-hr period could not be plotted as a simple linear function of time, as a slope change occurred at around 72 hours. The possibility of toxicity of accumulated tritiated thymidine is discussed. It is concluded that the results from the multiple applications of the label showed that in this system with a slower turnover, all the proliferative cells were in cycle and that the ratio of proliferative to differentiated cells was high; the design was suitable for repair. (C.O.)

45606 (ANL-7535, pp 116-18) DETERMINATION OF WHALE LIFE-SPANS. Frigerio, Norman A.; Sacher, George A. (Argonne National Lab., Ill.).

Although estimation of sperm whale age by fallout accumulation did not prove feasible, the absence of fallout in these creatures gives some interesting insight into fallout transport to and through the depths of the polar oceans. Tritium age measurements of fin whale earplugs, however, did prove practical and strongly suggest that one complete lamina is formed each year. Thus, the life-span of the whale is similar to that of man or elephant, despite very marked differences in metabolic rate and in brain/body-weight ratio. In the light of current ageing theory this similarity suggests that the same factors are important in fixing the longevity of all mammals under normal conditions and, very probably, under irradiation as well. The encouraging outcome of the first trial of the tritium dating procedure, taken together with the scientific and economic importance of the problems, justify continued investigation of age determination by radionuclide dating. (auth)

45607 (ANL-7535, pp 281-3) PRODUCTION OF FULLY DEUTERATED AMINO ACIDS FROM SMALL-SCALE ALGAL CULTURES IN HEAVY WATER. Klein, Peter D.; Szczepanik, Patricia A. (Argonne National Lab., Ill.).

In order to gain practical experience in the production of biosynthetically labeled amino acids, a small-scale algal production system was established and the associated procedures for preparative scale isolation of amino acids were developed. Cultures of Scenedesmus obliquus in 99% D_2O were feasible sources for the preparative isolation of fully deuterated amino acids. It was concluded that the cost of the heavy water used was offset by the additional by-products obtained and by recycling of the solvent after each use. (C.O.)

45608 (ANL-7535, pp 285-7) EVALUATION OF COMBUSTION METHODS FOR THE MEASUREMENT OF TRITIUM. Kisieleski, Walter E.; Huebner, Leonid G. (Argonne National Lab., Ill.).

The vacuum-line method was compared with the conventional oxygen-flask technique for combustion in determination of tritium by scintillation counting. The counting efficiency and quantitative recovery of tritium from biological materials is compared, and the effect of quenching on these measurements is analyzed. Advantages of the vacuum-line method are discussed. (M.C.G.)

45609 (CNM-R-2(Vol.2), pp 797-825) BIOLOGICAL AND MEDICAL UTILIZATION OF RESEARCH REACTORS. Frigerio, Norman A. (Argonne National Lab., Ill.).

The biomedical utilization of nuclear reactors is illustrated by examples drawn from five regions of interest. Under activation analysis attention is drawn to the possibilities of thermal and epithermal activation for purely instrumental determinations of blood Cl, Na, K, Br, As, etc., as well as to other applications in clinical medicine and biomedical research. Fast neutron and secondary particle activations are suggested for Li, B, C, N, O, F, Mg, P, S, and Pb. The advantages of local production are outlined for the short-lived radionuclides ^{42}K, ^{64}Cu, ^{76}As, ^{27}Mg, ^{82}Br, ^{80m}Br, ^{18}O, ^{16}N, ^{13}N, ^{15}O, ^{18}F, and ^{28}Mg, and some suggestions are presented as to their applications in biology and medicine. The biomedical possibilities of neutron radiography, autoradiography, and diffraction are outlined, and methods suggested for their future use. Principles and practical expedients are presented for the rational use of reactor γ, and thermal, epithermal, and fast neutrons in radiobiology. Similar guidelines are given for the therapy utilization of reactors, via the fast neutron, conversion, and capture modes that were proposed. (auth)

45610 (STI/PUB-218) TRACE MINERAL STUDIES WITH ISOTOPES IN DOMESTIC ANIMALS. Panel Proceedings Series. Proceedings of a Panel held in Vienna, 28-31 October 1968. (International Atomic Energy Agency, Vienna (Austria)). 1969. 158p. (CONF-681065). IAEA: $4.00; Austrian Schillings 104,-; Pound 1.13.4; F. Fr. 19,60; DM 16,-.

Proceedings of a panel organized by the Joint FAO/IAEA Division of Atomic Energy in Food and Agriculture and held in Vienna, 28 to 31 October 1968. The meeting was attended by 23 experts from ten countries and two international organizations. The contents include, among others, papers on placental transfer of iron, copper metabolism in cows, manganese metabolism in poultry and in ruminants, competition between trace elements, and neutron activation analysis for the determination of selenium in biological materials. With the exception of one French paper, all papers and the recommendations of the panel are in English. A separate abstract is prepared on the neutron activation analysis paper. (E.R.B.)

For an abstract of the individual paper see: 45611.

45611 NEUTRON ACTIVATION ANALYSIS FOR THE DETERMINATION OF SELENIUM IN BIOLOGICAL MATERIALS. Leibetseder, J. (Veterinary Coll., Vienna). pp 77-95 of Trace Mineral Studies with Isotopes in Domestic Animals. Vienna, International Atomic Energy Agency, 1969.

From Panel on Trace Mineral Studies with Isotopes in Domestic Animals, Vienna, Austria. See STI/PUB-218; CONF-681065.

In the studies of trace elements, numerous quantitative analyses of the element in biological material are always necessary. Since selenium is known as a trace element the problem of a rapid and relatively cheap determination also exists for this element. Apart from atomic absorption spectrometry, neutron activation analysis now seems to be a suitable method of analyzing selenium with little effort and time-consumption but with high sensitivity and sufficient accuracy. A brief review of the method of selenium determination other than by neutron activation analysis is given. (auth)

45612 ANALYSIS OF ERRORS IN A TECHNIQUE FOR THE COMBINED USE OF MULTIPLE RADIOISOTOPES. McTaggart, Wesley G.; Cardus, David (Baylor Univ., Houston, Tex.). Int. J. Appl. Radiat. Isotop., 20: 429-36(June 1969).

The ability to maintain only a small error was uncertain in a technique which involved the simultaneous use of five radioisotopes, and a systematic in vitro investigation was undertaken to

assess the technical errors and the total error in the technique. Technical errors in counting activity, pipetting samples, and measuring tracer volumes were determined separately. Sixty-eight determinations of five known volumes of water were made to evaluate the total error. The results of the in vitro volume estimates were submitted to statistical analysis. Four questions were asked. (1) Was there a significant difference between the estimated volumes obtained by the five isotopes and the known volumes? (2) Was there a significant difference between the estimated volume obtained with each isotope and that obtained with the other isotopes? (3) Were all the volume levels studied estimated with the same degree of accuracy by each of the five isotopes? (4) Can changes in volume of ten percent, at levels of 2 l and 10 l be estimated with sufficient accuracy to enable quantitative statements to be made about estimates of equivalent changes in physiological volumes? The technical errors in the technique were small, resulting in an average total error of 0.85 percent between the known and estimated volumes using pooled data. Each isotope was found to be equally as accurate as the other isotope in estimating any of the volumes studied. This in vitro assessment of errors indicates the techniques to be sufficiently accurate and reproducible to be utilized in a quantitative estimate of changes in physiological volumes. (auth)

45613 ON RADIOACTIVE LABELING OF PROLIFERATING CELLS: THE GRAPH OF LABELED MITOSIS. **Bronk, B. V. (Brookhaven National Lab., Upton, N. Y.). J. Theor. Biol., 22: 468-92(Mar. 1969).**

The interpretation of the results of radioactive labeling during the state of DNA synthesis is discussed in terms of the model of proliferating cells in which the time spent in each state is determined stochastically. Using renewal equations for the labeled and unlabeled populations, the birth rate of labeled cells, the labeling index, and various aspects of limiting forms of the labeling index are discussed. It is shown that the index can be well represented by its asymptotic value plus the product of a cosine function (with a period slightly less than the doubling time) and a decaying exponential for times long after labeling. Modifications due to cell death and differentiation are considered. It is shown that some of the results obtained are insensitive to a uniform death rate or differentiation. This is in contrast to the behavior of the fractions-in-state, which are found to depend strongly on the multiplication rate at the end of the cycle. It is found that the asymptotic labeling index is given by the fraction of time in S rather than the log-phase fraction in S as one might expect. This makes a significant difference if the state labeled has a short transit time compared to the cycle time and occurs at one end of the cycle. (BBB)

45614 AUTOMATIC DIGITAL INTEGRATION OF RADIO-IMMUNOASSAY CHROMATOELECTROPHORESIS PEAKS. **Hawker, Charles D. (Univ. of Pennsylvania, Philadelphia). Anal. Biochem., 30: 144-6(July 1969).**

An in vitro radioimmunoassay for parathyroid hormone was set up and four methods for determining the chromatoelectrophoresis peaks were used. These four methods were: automatic digital integration, planimetry, semiautomatic disc integration, and cut strip γ-counting. The correlation between these methods was expressed in terms of the ratio of bound peak area to free peak area. (E.R.B.)

45615 IN VITRO METHODS OF THYROID INVESTIGATION. **Besson, R. (Hopital Beaujon, Clinchy, France). pp 157-71 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).**

The mode of transport of the thyroid hormones in the serum is described. Different protein-hormone bindings were studied, together with the site of preference for each hormone, as well as the concept of fixation capacity and competition for the different sites between the endogenous hormones and added exogenous hormones. Radioisotope techniques use for in vitro studies are described. The information so derived gives a more precise understanding of the mechanism of the Hamolsky test, allows its limits to be defined, and facilitates its use as one of the methods of thyroid investigation. The test has the advantage of being carried out in vitro. Its value was confirmed by an experiment which has been in progress for the past few years. (22 references.) (auth)

45616 THE USE OF A RADIO-IMMUNOLOGICAL METHOD FOR ASSAYING INSULIN AND FOLLICLE STIMULATING HORMONE IN MAN. **Rosselin, G.; Dolais, J. (Institut National de la Sante et de la Recherche Medicale, Paris). pp 189-217 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).**

The theoretical and practical aspects of applying radioimmunological techniques to the assay of protein hormones are examined from two different aspects. After reviewing other techniques for insulin assay the authors stress the usefulness of adsorption of the antigen on talc. At the present time the assay of insulin by this method seems to be quicker, more easily controlled, more readily transferable and relatively less expensive. The method for assaying follicle stimulating hormone involves the purification of iodinated F.S.H. on amidon gel and immunological analysis of the fractions obtained. Quantitative examination of the direct and indirect reactions indicates a multispecificity of the F.S.H. molecule in man. It has also allowed a radioimmunological system to be isolated which facilitates assay of the molecule in complex biological media with a high degree of sensitivity and specificity. (auth)

45617 ROLE OF THE RADIOISOTOPES IN THE STUDY OF THE MECHANISMS OF PROTEIN BIOSYNTHESIS. **Kruth, J. (Hospital des Enfants-Malades, Paris). pp 173-87 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).**

The rapid development of molecular biology during the past few years results in part from the use of isotopic methods. Using these methods, proteins, nucleic, acids, and intermediaries of their biosynthesis which are present in the cell in only small quantities, but which possess important biological and metabolic properties, can be characterized. The following fundamental discoveries have been based on work using radioisotopes; the mechanism of protein biosynthesis at the sub-cellular level; the discovery of messenger RNA's, the study of their metabolism and mode of action; the partial structure of nucleic acids, particularly the messenger RNA's; the genetic regulation of protein biosynthesis, and evidence for the existence of repressor; and the complete determination of the genetic code. (54 references.) (auth)

45618 CELL POPULATION KINETICS. **Tubiana, M. (Institut Gustave Roussy, Villejuif, France). pp 219-49 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).**

The aims of cell population kinetics studies are: the measurement of the life span and of the mitotic cycle of cells, the analysis of cellular proliferation, of cell differentiation, cell migration, and of cell turnover in tissues. With radioactive precursors of DNA such as thymidine-^{3}H it has become possible to label cells and to recognize the labeled cells on an autohistoradiogram. The possibilities, the difficulties, and the limitations of these techniques are illustrated and discussed in three types of research: the kinetics of cell proliferation during tumor growth; the cell turnover in the gastrointestinal tract; and the kinetics of erythrocytic precursor proliferation. (71 references.) (auth)

45619 LYMPHOCYTE CIRCULATION IN CHRONIC LYMPHATIC LEUKAEMIA STUDIED BY LABELLING METHODS. **Binet, J.-L.; Laudat, Ph.; Villeneuve, B.; Becart, Renee; Bernard, Jean (INSERM, Hopital Cochin, Paris). pp 251-8 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).**

Lymphocytes can be labeled in vitro using isotopic tracers. Their fate can then be followed after reinjection into the patient either by autoradiography or by measuring the beta activity of the isotope employed. Four patients with chronic lymphatic leukemia were studied in this way and the results suggest that in contrast to the normal subject, the lymphocytes in the peripheral blood are not in equilibrium with extracirculatory lymphocytes. This explains the modified lymphocyte circulation which occurs in chromic lymphatic leukemia. (10 references.) (auth)

45620 THE STUDY OF PLATELET AND GRANULOCYTE KINETICS USING ISOTOPIC METHODS. **Najean, Y.; Ardaillou, N.; Dresch, C. (Hopital St-Louis, Paris). pp 259-88 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).**

The life span of circulating blood platelets and their site of destruction can be measured accurately by isotopic techniques. The investigation often yields results which are clinically useful. Thrombocytopoiesis can at the moment only be estimated indirectly. In vitro labeling of leukocytes allows their life span in the circulation to be measured. This is of little apparent clinical relevance, but it is also possible to calculate the leukocyte compartments and identify spurious leukopenias. Leukopoiesis has been studied by special techniques which for the moment have no clinical application. Methods involving autoradiography after an injection of tritiated thymidine give the most information in the study of the kinetics of granulocyte proliferation. (12 references). (auth)

45621 PROCEDURE FOR DETERMINATION OF ALDOSTERONE IN HUMAN PERIPHERAL PLASMA BY DOUBLE-ISOTOPE DERIVATIVE ASSAY, AND ITS APPLICATION FOR MEASUREMENT OF SECRETORY RATE AND URINARY EXCRETION. **Nowaczynski, W.; Silah, J.; Genest, J. (Hotel-Dieu Hospital, Montreal). Can J. Biochem., 45: 1919-36(Dec. 1967).**

A procedure for the determination of peripheral plasma aldosterone, in which ^{14}C-labeled aldosterone serves as the marker, and the acetylating agent is relatively inexpensive tritium-labeled acetic anhydride of high specific activity is reported. A new method for the chromatographic purification of aldosterone and aldosterone diacetate is presented. This procedure provides a better separation of these two compounds from the unlabeled and labeled impurities. (auth) (Canada)

Metabolism, Physiology, and Toxicology

Refer also to abstracts 45209, 45721, 45723, 45726, 45763, 45770, 45783, 45794, and 45845.

45622 (AD-690129) A MODIFIED ^{59}Fe FERROKINETIC PROCEDURE. Final Report, November–December 1968. Logsdon, Donald F. Jr.; Green, James F.; Harper, John W. (School of Aerospace Medicine, Brooks AFB, Tex.). Apr. 1969. 11p. (SAM-TR-69-24). CFSTI.

In an effort to reduce the exposure dose from the ^{59}Fe ferrokinetic procedure, the injection dose was reduced from 6 μCi to 0.6 μCi. Although the count rate was reduced, counts above background were obtained. The blood volume, plasma iron clearance, and red cell iron uptake were measured and found to be within normal limits. Measurement of ^{59}Fe in the spleen, heart, liver, and sacrum by external counting produced curves closely similar to those found with the higher dose. The whole body exposure dose was reduced from 110 mrem to 11 mrem. (TAB)

45623 (AEC-tr-7087) METABOLISM AND TOXICITY OF THERAPEUTIC CHELATING AGENTS. REPORT NO. 4. EXCRETION AND CATABOLISM OF EDTA AND DTPA. Havlicek, Frantisek; Bohne, Felicitas; Zorn, Herbert. Translated by A. A. Horvath (Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex.), from Strahlentherapie, 136: 604-8(1968). 10p. Dep. CFSTI.

The excretion of ^{14}C-labeled EDTA and DTPA was studied in rats. Within 24 hours 95% of the radioactivity was excreted with the urine, 0.5% with the feces, and 0.7 to 1.3% with the expired CO_2. From the experiments a metabolic degradation of the chelates can be deduced which concerns mainly the acetate groupings. This decay does not depend on the chelated metal or on the dose of the chelate but only on the ligand. It seems likely that the metabolic decay takes place in the kidneys. (auth)

45624 (ANL-7535, pp 59) RETENTION OF RADIOSTRONTIUM IN SOFT TISSUES. Brues, Austin M.; Auerbach, Harry; Grube, Donald D.; DeRoche, Georgia M. (Argonne National Lab., Ill.).

Beagle dogs 5 months of age were injected intravenously with ^{85}Sr. At the same time, a 4-yr-old beagle, which had been injected with ^{85}Sr last year, was reinjected to investigate the effects of age on the plasma curve. Plasma levels were measured at 10 min and up to 75 days postinjection. The plasma specific-activity curve of the 4-yr-old dog was not significantly different from that found last year. The curve for the 5-mo-old dog fell much more rapidly and at 1 to 2 days was lower by a factor greater than 10. The specific-activity integrals (μCi days/g plasma per μCi/g body weight administered) were 3.1 days for the older dog and 0.42 days for the younger dog. Additional work compared ^{85}Sr retention in plasma and soft tissues of mice and rats. (C.O.)

45625 (COO-1762-4) GROWTH OF UTERINE AND PLACENTAL VASCULATURE. Technical Progress Report. Makowski, Edgar L. (Colorado Univ., Denver. Medical Center). [Sept. 5, 1969]. Contract AT(11-1)-1762. 29p. Dep. CFSTI.

A method was developed for estimating the magnitude and distribution of regional blood flow by means of radioactive microspheres. The method was used to measure umbilical blood flow and to quantitate the distribution of uterine and umbilical blood flows to sheep placentae. Polyvinyl catheters were inserted into the main umbilical vessels of eleven fetuses, and a double lumen catheter was inserted into fetal hindlimb veins. A 15% solution of antipyrene was continuously infused through one catheter; microspheres labeled with ^{169}Yb or ^{51}Cr were injected through the other catheter. Fifty minutes after the start of antipyrene infusion, 0.6 ml samples were obtained from each umbilical artery and vein for antipyrene analyses. During injection of microspheres blood samples were withdrawn at a constant rate from the umbilical arteries and veins for a total of 4 min. The pregnant uterus was then removed and the total radioactivity of both the placental cotyledons and intercotyledonary chorion was used to calculate umbilical blood flow. Ratios of maternal perfusion to fetal perfusion in the sheep placenta were investigated using twelve pregnant sheep in the last months of gestation. The distribution of microspheres over the surface of the placenta was mapped in three ways: the distribution of ^{169}Yb or ^{141}Ce on the fetal side; the distribution of ^{51}Cr on the maternal side; and the distribution of the ratio of $^{51}Cr/^{169}Yb$ or $^{51}Cr/^{141}Ce$. Results are shown by means of tables and graphs. (H.L.W.)

45626 (NYO-2753-7) ^{90}Sr LEVELS IN THE DIETS AND BONES OF CHILDREN. Progress Report, 1969. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). 72p. Dep. CFSTI.

The levels of ^{90}Sr and stable strontium in human bones and in the diet of the young segment of the Argentine population were determined. The derivation of parameters describing strontium metabolism is presented, thus providing the means for estimating risk to man from possible future contaminations of food chains by radiostrontium. Radium-226 determinations were also carried out in samples of bone and foodstuff. The data, all of which are presented in tabular form, are organized as follows: Determination of strontium metabolic parameters. This involved the determination of $^{90}Sr/Sr$ specific activity and Sr/Ca ratios in bone samples, and the reconstruction of the corresponding diet history. Values of these parameters as a function of age up to 20 yrs are given. Strontium-90 in diets during 1968. Using current measurements and diet structures previously presented, the ^{90}Sr levels in the total diet of several age groups were estimated for 1968. Radium-226 in bone and diets. Data from bone samples and diet analysis for 1968 are presented. The contribution of breast feeding in the 0 to 6 month diet was estimated from the results of analysis of human milk samples. (E.R.B.)

45627 (ORNL-TM-2660) INTERNAL DISTRIBUTION AND LOSS FROM ROOTS BY LEACHING OF ^{137}Cs INOCULATED INTO LIRIODENDRON TULIPIFERA L. SEEDLINGS GROWN IN SAND CULTURE. Sandberg, Gary R.; Olson, Jerry S.; Clebsch, Edward E. C. (Oak Ridge National Lab., Tenn.). Sept. 1969. Contract W-7405-eng-26. 68p. Dep. CFSTI.

Thesis. Submitted to Univ. of Tennessee, Knoxville.

Two-year-old tulip poplar seedlings were grown in heavily fertilized sand culture. Each seedling was inoculated with 1.5 microcuries of cesium-137 and harvested at certain periods during the growing season. The subsequent distribution of cesium-137 in the plant, including the roots, was studied and was compared with the amount of cesium-137 lost from the root system by leaching with two rates of application of water. Dead roots were periodically collected, and the contribution of cesium-137 to the leachate from the death of roots was estimated. Approximately 32 percent of the inoculated cesium-137 was leached from the plants; root death accounted for one-fourth of this loss. The remaining 75 percent of the loss is credited to exudation and possibly sloughing off of cells from the root cap. Exudation of cesium-137 did not increase with movement of cesium-137 to the roots during the growing season or to increased rates of water used to leach cesium-137 from the roots. (auth)

45628 (SWRHL-63-r) AGRONOMIC ASPECTS OF THE EXPERIMENTAL DAIRY FARM, JANUARY 1966–DECEMBER 1968. Daley, E. M.; Smith, D. D. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Aug. 1969. 41p. Dep. CFSTI.

An experimental form facility was established on the Nevada Test Site to study the transport of radioiodine through the atmosphere-forage-cow-milk-man chain. The facility and agronomic procedures practiced are described. (C.H.)

45629 EXPERIMENTAL STUDY ON RADIOISOTOPE MUSCULAR CLEARANCE IN INJURIES OF CENTRAL NERVE AND VESSELS. Mizoguchi, Fujio (Juntendo Univ., Tokyo). Nippon Geka Hokan, 38: 482-97(May 1969). (In Japanese).

Recently much attention has been paid to the peripheral circulation of patients under hypothermia and microcirculation of patients with edema. The ratio of static to kinetic muscular clearance was calculated on normal dogs with ligation of femoral artery. Clearance time of gastrocnemius muscle in such condition as head injuries, spinal injuries, and femoral vessel injuries were measured with scintillation counter following the injection of $^{131}I-Na$ into the gastrocnemius muscle 1 cm deep. The curve which was obtained by these method was put into the semi-logarithmic graph, and the t 1/2 was calculated. In normal dogs, the average static muscular clearance t 1/2 was 4.5 ± 0.4 min, and the average kinetic muscular clearance t 1/2 was 3.4 ± 0.5 min. The ratio of static to kinetic clearance was 1.35. In dogs with the femoral artery and vein ligated, the t 1/2 were prolonged markedly immediately after ligation, though the t 1/2 recovered gradually as time elapsed. The t 1/2 of dogs that received arterial ligation and lumbar sympathectomy showed almost the same as that of normal. Radioactive build-up curve showed 32% decrease of the blood circulation volume immediately after arterial ligation, but seven days after it went up to 94.4%. Dogs with brain contusion showed the most prolonged t 1/2 3 to 4 days after injuries, and

16 days after t 1/2 recovered completely. In cases of cerebral compression (a balloon containing 3 to 4 ml water was inserted into the subdural space), remarkable difference in clearance time was not recognized. In dogs with spinal injury, the t 1/2 was slightly prolonged two days after injury, but after that it was not prolonged though there appeared muscular atrophy. (NSA of Japan)

45630 HISTOCHEMICAL EVALUATION OF THE EFFECT OF RADIOISOTOPES ON DEHYDROGENASES IN LYMPH NODES. Aso, Yoshio; Hoshino, Yoshinobu (Tokyo Univ.). Nippon Hinyokika Gakkai Zasshi, 60: 433-8(May 1969). (In Japanese).

Changes of the activities of succinic dehydrogenase, glucose-6-phosphate dehydrogenase and lactic dehydrogenase in lymph nodes were estimated histochemically in humans and rabbits. The histochemical activities of those dehydrogenases were changed on the administration of radioisotopes before the histological changes by H.E. staining were observed. The staining intensities of those enzymes increased with lower radioactivity, while they decreased with higher ones. In rabbits, it was noted that the activities of those enzymes decreased markedly with a large dose of the radioisotope. The results suggest that intralymphatic administration of radioisotopes might be useful in the treatment of malignancy and the prevention of tumor cell dissemination in lymphography. Further study is necessary before the clinical effectiveness of this method can be confirmed. (NSA of Japan)

45631 METABOLISM OF TELLURIUM IN RATS. Hollins, J. G. (National Research Council of Canada, Ottawa). Health Phys., 17: 497-505(Sept. 1969). (NRCC-10669).

The metabolism of ^{127m}Te as tellurous acid in rats was studied by gamma-ray counting of the whole body, various tissues, and the excreta. The whole-body retention of tellurium after intraperitoneal injection or gavage may be described by a sum of exponential terms. The variation with time of the tellurium content of the analyzed tissues was examined and shown to fit the whole-body retention curve. (auth) (UK)

45632 URINARY EXCRETION OF PLUTONIUM DEPOSITED IN THE LUNG. Nelson, I. C. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Health Phys., 17: 514-16(Sept. 1969).

Early studies performed by Langham and coworkers (1950) resulted in mathematical expressions with which measurements of plutonium in urine could be used to estimate amounts retained in the body. These expressions were based upon data obtained from studies of urinary excretion rates following intravenous injection of plutonium citrate in terminal patients and are strictly applicable only to cases where plutonium has been injected directly into the blood-stream. Healy (1957) developed a theoretical model relating urinary excretion to estimates of lung depositions of plutonium. Here it was assumed that small but continuous additions of plutonium were made to the bloodstream from a pool of slightly soluble plutonium in the lung. By applying the Langham expression for urinary excretion of plutonium to each of these additions, followed by summation of the incremental contributions, the total urinary excretion was obtained. Uncertainty in the values for urinary excretion obtained with this model for times soon after intake prompted a re-examination of the theoretical development. The result of this work is a mathematical approximation of urinary excretion of plutonium deposited in the lung which appears to be more consistent with the experimental bases. (auth) (UK)

45633 ROLE OF RADIOACTIVE ISOTOPES IN THE DIAGNOSIS OF GASTRO-INTESTINAL DISEASE. Powell, L. W. (Royal Brisbane Hospital). Med. J. Aust., 2: 359-63(Aug. 16, 1969).

Techniques are evaluated to measure gastro-intestinal absorption of iron, using ^{59}Fe as a label, of vitamin B_{12}, using the ^{57}Co- or ^{58}Co-labeled vitamin, of dietary fats, using ^{131}I- or ^{14}C-labeled fats and of folic acid and vitamin D, using tritiated vitamins. Techniques designed to detect and measure excessive blood and protein loss into the gastro-intestinal tract using ^{51}Cr, ^{59}Fe and ^{55}Fe are evaluated. Radioactive, non-absorbable markers have been used as internal standards for absorption and balance studies, including ^{140}lanthanum, ^{91}yttrium chloride, ^{131}barium, trivalent chromium ($^{51}CrCl_3$ or $^{51}Cr_2O_3$) or red cells labeled with $Na_2{}^{51}CrO_4$. Hepatic and pancreatic scintiscanning are now established techniques for the diagnosis of space-occupying lesions. It is hoped that reliable techniques will be developed in the near future for routine use in the diagnosis of gastro-intestinal neoplasms. (Australia)

45634 ^{90}Sr-INDUCED BONE TUMORS IN MINIATURE SWINE. Howard, E. B.; Clarke, W. J.; Karagianes, M. T.; Palmer, R. F. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Radiat. Res., 39: 594-607(Sept. 1969).

Fourteen bone tumors, classified as either osteosarcomas or giant cell tumors, have occurred in nine Pitman-Moore strain miniature swine chronically exposed to ^{90}Sr. Five had been exposed by daily feeding of 125 μCi of ^{90}Sr, and two had received single intravenous injections of 64 μCi kg body weight. Two had been weaned from 625 μCi/day sows and were fed 156 μCi/day for a short time, followed by no additional radionuclide feeding. The majority (12) of the tumors occurred in the skull, including the mandible and maxilla, and in most cases appeared to arise from sites of severe radiation osteonecrosis where bone resorption and fibrosis were prevalent. Of significance was the observation that in each case where it was possible to determine the origin, the bone tumors arose near or within the periosteal surface of the bone. (auth)

45635 UPTAKE AND TRANSLOCATION OF ^{134}Cs, ^{59}Fe, ^{85}Sr, AND ^{185}W BY BANANA PLANTS AND A COCONUT PLANT FOLLOWING FOLIAR APPLICATION. Thomasson, W. Neill; Bolch, W. Emmett; Gamble, J. F. (Univ. of Florida, Gainesville). Bioscience, 19: 613-15(July 1969).

As part of the bioenvironmental studies on the feasibility of use of nuclear explosives for excavation of a sea-level canal in Central America, an evaluation was made of the uptake of several important radionuclides in selected tropical fruits. Samples of food crops and milk were collected in the Panamanian and Colombian study areas and analyzed by γ-ray spectrometry for existing levels of radioactivity. A differential uptake study of mixed radionuclides was performed over a 17-day period on a Malaysian dwarf coconut palm and a banana plant. Soluble forms of carrier-free ^{185}W, ^{85}Sr, ^{134}Cs, and ^{59}Fe were applied to the fronds of the coconut palm and the leaves of the banana tree. In another study, three dwarf banana plants were treated with ^{134}Cs because of its rapid uptake and translocation during the first experiments. There was a high selectivity for Cs uptake over the other three radionuclides in the banana and coconut plants. There was greater translocation in the banana plant than in the coconut by at least one order of magnitude. In fact, Cs exhibited measurable movement to adjacent plants 15 to 20 ft away. There was slight but measurable concentration of ^{185}W in the banana peels of the fruit of the treated tree, as well as the peels of fruit from adjacent trees; however, no ^{185}W was found in the fruit. There was much less translocation of ^{134}Cs to the fruit of the coconut tree. Small amounts of ^{185}W, ^{85}Sr, and ^{59}Fe were translocated to untreated fronds above and on the opposite side of the palm from the treated fronds. The only radionuclide detected in any part of the fruit was ^{134}Cs. (BBB)

45636 DISTRIBUTION AND FATE OF ^{54}Mn IN THE RAT, WITH SPECIAL REFERENCE TO THE CNS. Dastur, Darab K.; Manghani, Daya K.; Raghavendran, K. V.; Jeejeebhoy, K. N. (Tata Memorial Hospital, Bombay). Quart. J. Exp. Physiol., 54: 322-31(July 1969).

The distribution and turnover of ^{54}Mn were observed in the rat over a prolonged period, by measuring the activity in the blood and tissues and by conducting whole-body counts. A dose of 20 μCi of carrier-free $^{54}MnCl_2$ or ^{54}Mn-maleate contained in 1.0 or 2.0 ml was injected intraperitoneally into 250 g animals that were sacrificed at 15 min to 34 days later. While the curve for the whole body and for most organs could be resolved into two exponential components, the slower component was not present for the uptake of ^{54}Mn in the central nervous system (CNS). The blood seemed to serve as a transport medium receiving and discharging the ^{54}Mn rapidly. While most organs showed a gradual decline with time (as cpm/g of tissue and in the retained dose), the brain and spinal cord exhibited a steady rise. The adrenal, pituitary, heart, and bone also showed this to some extent. The greater capacity for relative retention of a small dose of ^{54}Mn by the CNS might be responsible for its selective vulnerability in chronic manganism. (BBB)

45637 INFLUENCE OF BACTERIAL POLYSACCHARIDE FROM B. PRODIGIOSUS ON DISTRIBUTION OF ^{131}I-MARKED FIBRINOGEN IN MICE WITH 180 (CROCKER) SARCOMA. Gasperovich, N. V.; Voznesenskaya, L. A. (Inst. of Experimental and Clinical Oncology, Moscow). Byull. Eksp. Biol. Med., 68: No. 7, 79-81(July 1969). (In Russian).

In preceding communications it was shown that ^{131}I-tagged fibrinogen was retained in the tissue of reinoculated tumors to a greater extent than in other organs and tissues studied. In this paper it is shown that the aid of a pyrogen polysaccharide from Bacillus prodigiosus it is possible to increase retention of radioactive iodine, bound with fibrinogen in tissues. In the majority of cases there was a selective retention of radioactive fibrinogen in nodes of the transplanted tumors. (auth)

45638 HYALURONIDASE AND PENETRATION OF ORGANISMIC BARRIERS. Prakapchuk, A. Ya.; Gryngauz, M. Ya.; Yaromenka, S. A. (Minsk State Medical Univ.). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk, No. 3, 71-5(1969). (In Ukrainian).

The uptake of ^{35}S, ^{204}Tl, and ^{131}I through the skin was studied in 36 guinea pigs and 12 rabbits treated with injections of hyaluronidase. The isotopes were introduced in mixtures of 1μCi per 10g of lanolin or artificially produced spermaceti oil. The data showed a maximum uptake of ^{35}S by lungs, liver, kidney, and testicles. The maximum uptake of ^{131}I was found in the thyroid gland and to a lesser extent in lungs, spleen, and liver with negligible amounts in brain tissues. Thallium-204 accumulated mostly in liver, kidneys, thyroid gland, and lungs. The radioactivity of all organs studied increased significantly within 48 hr. It was also confirmed that treatment with hyaluronidase reduced protective functions of blood-tissue barriers in the animals. (R.V.J.)

45639 UPTAKE AND INCORPORATION OF LEUCINE AND THYMIDINE IN DEVELOPING SEA URCHIN EGGS. THE EFFECT OF D_2O. Pinard, J.; Bellemare, G.; Aubin, A.; Daigneault, R.; Cousineau, G. H. (Univ., Montreal). Exp. Cell Res., 56: 254-8(Aug. 1969).

Corrected incorporation rates (percent ratio of incorporation over uptake) for ^{14}C-DL-1-leucine and ^{14}C-2-thymidine in developing sea urchin eggs of Strongylocentrotus purpuratus, and the effect of deuterium oxide (D_2O, 99.75%) are presented. Results obtained show that from fertilization to 8 hr after fertilization the rates of leucine incorporation into protein are identical for both control and deuterated cells. Whereas the rates of thymidine incorporation into DNA of seawater-treated embryos increase from first division to the young blastula stage, the rates observed for the deuterated cells are not only much lower but decrease at 8 hr after fertilization. (auth)

45640 INCORPORATION OF ^{131}I INTO DOG FIBRINOPEPTIDES. Blombaeck, Birger; Zetterqvist, Eric (Karolinska Institutet, Stockholm). Acta Chem. Scand., 23: 1137-44(1969).

On iodination of dog fibrinogen, ^{131}I was incorporated in fibrinopeptide B_1. This peptide is released during clotting. Monosubstitution in tyrosine residues of the peptide was the main reaction. The possible substitution in tyrosine-O-sulfate and histidine residues is discussed. (auth) (Denmark)

45641 ^{210}Pb IN SELECTED MARINE ORGANISMS. Beasley, Thomas Miles. Corvallis, Oreg., Oregon State Univ., 1969. 92p. Thesis.

The concentrations of ^{210}Pb have been determined in a variety of marine organisms. The specimens analyzed were taken during different times of the year and consequently during different hydrographic regimes which afforded the opportunity to compare ^{210}Pb concentrations in organisms living in upwelled water further from shore. Less extensive measurements of ^{210}Po in the same species permitted an estimate of the radiation dose rate to which these organisms may be subject from this internally deposited isotope, in addition to that which results from cosmic rays and the ^{40}K which is ubiquitous in ocean waters. The concentrations of ^{210}Pb in marine organisms from trophic level II and III were generally well correlated with inshore and offshore stations. This can be explained if one considers the input of this isotope from rainfall and the offshore transport of isotope enriched water due to upwelling. During the conditions of high coastal rainfall inshore organisms residing in the surface layers of the ocean (upper 100 meters) displayed higher ^{210}Pb concentrations than did the same species offshore (>45 nautical miles). Under conditions of low rainfall and offshore transport of surface water, the organisms at more than 45 nautical miles offshore generally showed higher ^{210}Pb concentrations than did those inshore. Lead 210 concentrations in lanternfish, which have been shown to reside at different depths in the water column, displayed decreasing concentrations of ^{210}Pb as their depth of residence increased. Similar results reported for stable lead measured in waters off the California coast would suggest that perhaps inorganic processes regulate the amount of lead in surface waters rather than biological ones. Ratios of $^{210}Po/^{210}Pb$ in oceanic organisms exceeded 1 in all cases, showing preferential uptake of ^{210}Po even though the ratio of these isotopes in rainwater, the major input source, has been measured at ~0.1. Although the interpretation of this result requires clarification, it is postulated that changes in chemical form of the isotopes as they enter the marine environment, coupled with differences in the effective half life exhibited by each isotope in the organisms, combine to produce higher ^{210}Po levels than those observed for ^{210}Pb. The radiation dose rate for fishes residing near the surface is shown to increase some 6 fold as a result of internal ^{210}Po concentrations, yet this figure would be expected to show variation depending upon ^{210}Po input to surface waters, and turnover times in the organisms. Benthonic polychetes, which receive high dose rates from ^{226}Ra incorporated in marine sediments showed an increase in dose rate of some 2 fold, giving possible total dose rates approaching 1.4 Rad/year. (Disser. Abstr.)

45642 AN ELECTRON MICROSCOPE AUTORADIOGRAPHIC STUDY OF PLUTONIUM LOCALISATION IN RAT LIVER USING A ^{241}Pu Label. James, A. C.; Rowden, G. (Royal Free Hospital, London). Int. J. Appl. Radiat. Isotop., 20: 295-7(Apr. 1969).

The intracellular sites of deposition in the liver and the mechanisms of transport of plutonium and other colloidal metals are at present incompletely described. The reports from biochemical investigations of cell fractions have been conflicting as regards the association of injected plutonium with lysomes and other organelles. An autoradiographic study is described of the localization of plutonium at the electron microscope level in rats using an isotope mixture of plutonium containing a relatively high abundance of the soft beta-emitting plutonium-241. (auth)

Radiation Effects

Refer also to abstracts 45688, 45969, 45974, 45976, and 45977.

45643 (ANL-7535, pp 198-9) THE EFFECT OF ULTRAVIOLET IRRADIATION ON THE PROGRESSION OF CHINESE HAMSTER CELLS THROUGH THE CELL CYCLE. Han, Antun; Sinclair, Warren K. (Argonne National Lab., Ill.).

The effects of ultraviolet light on the progression of synchronized Chinese hamster cells, subline V79-S171, through the cell cycle were studied. Exposures to uv radiation were made to reduce the survival to about 20%. Cells were labeled with $^{3}HTdR$ and scored by means of autoradiography. Cells irradiated in S displayed considerable prolongation of the S period. The grain count (label) was markedly reduced, indicating a temporary inhibition of DNA synthesis. In cells irradiated at the G_1 stage a portion of the population was delayed at the end of G_1 before starting the S period. The grain count was greatly reduced, indicating an overall retardation of DNA synthesis once the cells were in S. The results indicated that the major effect of uv radiation was upon the synthesis of DNA, whether cells were irradiated in G_1 or S. The S cells showed a considerable lengthening of the DNA synthetic period and a marked reduction in DNA synthesis rate. In G_1 and G_2 cells, subsequent DNA synthesis appeared to be reduced in rate, and the cells entered synthesis slowly. (C.O.)

45644 (UCB-34-P-82-8) ELECTROPHYSIOLOGICAL AND BIOCHEMICAL STUDIES OF THE EFFECTS OF RADIATION ON BRAIN ACTIVITY AND DEVELOPMENT. Progress Report, August 1, 1968-July 31, 1969. Timiras, Paola S. (California Univ., Berkeley). Contract AT(11-1)-34. 38p. Dep. CFSTI.

Essential methods and techniques were established for routine use in the laboratory, allowing investigators to coordinate the different aspects of the overall project. Considerable data from previous electrophysiological studies were integrated at the biochemical level resulting in the formulation of a working hypothesis permitting a comprehensive research design. Data from the following areas of investigation are included as a part of the overall study of the effects of x radiation on the development of the central nervous system. The effects of neonatal whole-body x irradiation on choline acetyltransferase activity in various CNS areas. The effects of whole-body γ irradiation on growth of body, brain, testes, and adrenals in chickens. The effects of neonatal whole-body x irradiation on the anticonvulsant effects of diphenylhydantoin in rats and on the response of developing rats to hypnotic doses of barbital. Experiments on the effects of x irradiation on free amino acid content of various brain regions are still in progress. Collateral studies of the effects of x radiation on cultured CNS tissues include; tracer studies of the effects of x radiation on uridine incorporation into RNA in neural tissues, and analysis of cell migration in cultured CNS tissues. (ERB)

45645 CATALASE LEVELS AND RADIATION RESISTANCE IN THREE SPECIES OF WILD DUCK. Feinstein, Robert N.; Howard, Judith B.; Faulhaber, Joann T. (Argonne National Lab., Ill.). Int. J. Radiat. Biol., 15: 341-6(1969).

Three species of wild duck said to have very different LD_{50}'s of x-radiation do not differ significantly in catalase activity per gram body-weight. It is suggested that the wide variation in LD_{50} may be a reflection of such factors as age, adaptability to capture and penning, etc. A secondary finding of interest is that the breast muscle of these wild ducks has a significantly higher level of catalase activity than does the leg muscle. This relationship is reversed in domestic chickens, and it is suggested that muscle catalase activity may be a reflection of functional usage. (auth)

45646 CALCIUM-DEPENDENT STIMULATION OF MITOTIC ACTIVITY IN NORMAL AND IRRADIATED RAT THYMOCYTE POPULATIONS BY SOMATOTROPHIC HORMONE. Whitfield, J. F.; Rixon, R. H.; Youdale, T. (National Research Council of Canada, Ottawa). Int. J. Radiat. Biol., 15: 385-8(1969).

Mitotic activity in thymic lymphocyte cultures was studied as

to its dependence on calcium concentration, growth hormone, and cobalt-60 gamma radiation. Both calcium ions and growth hormone led to an enhancement of mitotic activity, while radiation caused inhibition. Up to 50 r, growth hormone counteracted the inhibitory effect of radiation probably through the hormone's effect on calcium. (H.B.G.)

45647 CHARACTERISTICS OF THE ENZYMATIC BREAKDOWN OF DNA IN ESCHERICHIA COLI IN RESPONSE TO IONIZING RADIATION. Chapman, J. D.; Pollard, E. C. (Pennsylvania State Univ., University Park). Int. J. Radiat. Biol., 15: 323-33(1969).

The temperature dependence of DNA degradation was characterized in E. coli B_{s-1} and an activation energy of 17.2 kcal/mole determined for the enzyme function between 20°C and 40°C. The maximum rate of the breakdown function was measured to be near 42°C. At temperatures greater than 45°C heat inactivation of the enzyme system in vivo was evidenced. The dependence of DNA degradation at 37°C on radiation dose was measured. The radiation appears to produce substrate for the degradative enzyme system, which is present in the cells as normal constituents of the cells. The Michaelis rate constant for such an enzyme reaction would be equivalent to a substrate concentration produced by 8.5 krads irradiation. The buoyant density of DNA throughout the degradative process was measured and found to be the same as double-stranded DNA from unirradiated cells. Models involving the in vitro mechanisms of actions of exonucleases I, II and II predict that a single-stranded component of the DNA should exist. This single-stranded component was not observed. (auth)

45648 THE IMPLICATION OF REPAIR PROCESSES IN THE MECHANISM OF DNA INTEGRATION BY LYMPHOMA CELLS. Ayad, S. R. (Univ. of Manchester, Eng.); Fox, Margaret. Int. J. Radiat. Biol., 15: 445-55(1969).

The uptake and integration of exogenous ^{3}H-IUdR labeled DNA by irradiated cultures of an IUdR resistant mutant of P338F cells has been studied by preparative CsCl density gradient centrifugation. Hydroxyurea (10^{-2} M) was found to inhibit DNA synthesis as measured by uptake of ^{14}C cytidine, but did not inhibit the integration of the exogenous DNA. This implies that enzymes involved in integration and repair are different from those concerned with DNA synthesis. Repair synthesis of DNA has been demonstrated after 150 and 400 rads of x rays. The amount of DNA uptake and integration was higher in irradiated cells and increased with increasing dose. Density-gradient centrifugation of DNA integrated into irradiated cells suggests the possibility of the release of nucleases from irradiated cells. The survival of the irradiated cells was unaffected by the integration of exogenous DNA. (auth)

45649 THE CHANGES IN CONJUGATED PHOSPHORYLATION AS AFFECTED BY THE POWER OF GAMMA-IRRADIATION OF COTTON SEEDLINGS. Arslanova, S. V. (Inst. of Experimental Plant Biology, Tashkent). Uzb. Biol. Zh., No. 3, 3-5 (1969). (In Russian).

The results of the investigation have shown that processes of oxidative phosphorylation depend not only on dose but also on power of irradiation. With increasing power of radiative oxygen consumption is increased and incorporation of inorganic phosphorus in phosphatic-organic compounds, in particular, in adenosine triphosphoric acid is inhibited. As a result phosphorus-oxygen ratio (P:O) is greatly increased. (auth)

45650 FREE RADICALS IN IRRADIATED SINGLE CRYSTALS OF 5-HALO-URACIL DERIVATIVES: 5-BROMOURACIL, 5-BROMODEOXYURIDINE AND 5-IODODEOXYURIDINE. Huettermann, Juergen; Mueller, Adolf (Kernforschungszentrum, Karlsruhe, Ger.). Int. J. Radiat. Biol., 15: 297-313(1969).

Electron-spin-resonance spectra of x- or γ-irradiated single crystals of 5-bromouracil (BU), 5-bromodeoxyuridine (BUDR) and 5-iododeoxyuridine (IUDR) were recorded at room temperature as a function of crystal orientation in the magnetic field at 35 GHz (Q-band) and, less extensively, at 10 GHz (X-band). The observed positions of hyperfine lines were fitted to theoretical curves by a computer program. The results clearly show the existence of two distinct groups of lines A and B. While the g-factor of group A is close to the free electron value, group B is shifted to lower magnetic fields and is further subject to large variations with changing orientation, both in position and intensity of hyperfine lines. Both groups are correlated to radicals at the pyrimidine group. It is proposed that one of these radicals is formed by hydrogen addition at the oxygen atom bound to C_4. Two resonance structures are possible, differing in localization of the unpaired spin density at either C_4 or C_6. The observed hyperfine splittings of group A fit completely into this scheme for all three substances investigated, if the unpaired spin is assumed to reside mainly at C_6 in IUDR and at C_4 in BU and BUDR. Two different radicals are proposed to account for group B having in common the main unpaired spin density at C_5. The radical structure assigned to BU may be formed by abstraction of hydrogen from N_1. It is characterized by two resonance structures with unpaired spin densities at N_1 and C_5 linked by a conjugated double bond. In BUDR and IUBR, the radical representing group B is produced by addition of a hydrogen atom at C_6 resulting in two β-protons at this position. (auth)

45651 THE SEARCH FOR X-RAY-INDUCED DNA DEGRADATION IN MOUSE L CELLS. Hill, M. (Inst. of Biophysics, Brno). Int. J. Radiat. Biol., 15: 483-90(1969).

X-irradiated mouse L cell cultures were analyzed for DNA degradation. The methods employed were sensitive enough to detect 0.1 per cent of DNA if degraded. No degradation was ascertained after the dose of 4000 rads which is known to induce non-S-phase DNA synthesis of about 0.05 to 0.1 per cent of cell DNA. The post-treatment with IOAM 10^{-5} M had no effect, although DNA synthesis was stopped and re-utilization of acid-soluble compounds thus eliminated. The results obtained markedly differ from those found in bacteria, and throw doubts on the view that an excision mechanism is operating in association with non-S-phase DNA synthesis. (auth)

45652 IMMEDIATE REACTIONS OF POTENTIAL DIFFERENCE AND RESISTANCE OF THE ISOLATED FROG SKIN TO X RAYS. Trott, Klaus-Ruediger (Univ., Munich). Int. J. Radiat. Biol., 15: 473-82(1969).

Potential difference and direct current resistance of the isolated frog skin were continuously recorded. Under irradiation with a dose-rate over 500 R/min and a dose over 1000 R the first reaction of the frog skin in well-oxygenated Ringer's is depolarization, which is followed by hyperpolarization. Under anoxic conditions only hyperpolarization can be found. The effect is highly dependent on the dose-rate, as in the case in most of the immediate reactions of organs and organisms to radiation hitherto observed. Possible mechanisms of action are discussed. (auth)

45653 SYNTHESIS OF NAD AND CATABOLISM OF NICOTINIC ACID IN THE ISOLATED PERFUSED LIVER OF NORMAL AND X-IRRADIATED RAT. Gerber, G. B.; Zicha, B.; Deroo, J. (Centre d'Etude de l'Energie Nucleaire, Mol, Belg.). Int. J. Radiat. Biol., 15: 425-34(1969).

The synthesis of NAD and the formation of catabolites from nicotinic acid ^{14}C was studied in isolated perfused liver from normal and x-irradiated rats. Large amounts of nicotinic acid and nicotinamide increase NAD content of perfused liver as they do in vivo. Synthesis of NAD is slightly diminished after irradiation, particularly under loading conditions whereas its catabolism is enhanced. Data for the rates of reactions are given for different pathways involved in NAD metabolism. (auth)

45654 DNA-DEGRADATION PRODUCTS FROM MAMMALIAN CELLS IRRADIATED WITH ULTRAVIOLET LIGHT. Cleaver, J. E. (Univ. of California, San Francisco); Trosko, J. E. Int. J. Radiat. Biol., 15: 411-24(1969).

Chinese hamster cells begin to die and degrade their DNA within 6 to 8 hours after 140 erg/mm^2 and 700 erg/mm^2 of uv light. Cell lysis releases macromolecular double-strand DNA and DNA degradative enzymes into the medium. Extracellular DNA degradation leads to an accumulation of thymidine and thymine in the medium. Intracellular degradation also occurs, and the acid-soluble fraction of the cells contains polynucleotides, phosphorylated derivatives of thymidine and thymine. Specific excision of thymine dimers in an acid-soluble form does not occur, and the contribution of DNA repair mechanisms to the observed degradation products is probably insignificant. No detectable amounts of DNA-degradation products (i.e., less than 0.05 per cent of total cellular DNA) were used for post-irradiation DNA synthesis. (auth)

45655 PYRIMIDINE NUCLEOTIDE BLOCKS OF DNA FRACTIONS OF BONE MARROW OF NORMAL AND X-IRRADIATED ANIMALS. Kritskii, G. A.; Surina, T. Ya. (Inst. of Biochemistry, Moscow). Biochemistry (USSR) (Engl. Transl.), 33: 575-80(July-Aug. 1968).

Translated from Biokhimiya, 33: 706-12(July-Aug. 1968).

A modified procedure has been developed for the separation of blocks of pyrimidine nucleotide fragments of DNA. The method is based on a combination of electrophoresis followed by paper chromatography. Chromatographic separation of the nucleotide blocks revealed at least 8 spots. The preliminary results indicated that localized x irradiation of rabbit bone marrow was followed immediately by alterations in the pyrimidine blocks of DNA oligonucleotide fragments. The blocks most sensitive to x radiation were those with the lowest T/C ratios and which ran slowest on the chromatograms. In normal animals the radiation sensitivity of the pyrimidine blocks was greater in the high-polymeric frac-

tion I of the DNA than in fraction II. The difference between these two fractions became much smaller immediately after x irradiation of the animals. (auth)

45656 DESTRUCTION OF A BIOLOGICAL ACTIVITY OF GIBBERELLIC ACID BY LOW DOSES OF IONIZING RADIATION. Sideris, E. G.; Kleinhofs, A.; Nilan, R. A. (Washington State Univ., Pullman). Contract AT(45-1)-353. Radiat. Bot., 9: 349-51(July 1969). (RLO-353-30).

It has been demonstrated that gibberellic acid treatment decreases the severity of the damage induced by ionizing radiation in a variety of plant tissues. Consequently, the effect of ionizing radiation on the biological activity of gibberellins as inducers of synthesis of enzymes essential for germination of cereal seeds may be of some importance to the study of the radiosensitivity of plant material. Evidence is presented for the in vitro destruction of a biological activity of gibberellic acid by low doses of gamma irradiation. (auth) (UK)

45657 THE EFFECT OF X-IRRADIATION ON THE BALANCE BETWEEN THE ALKALINE RIBONUCLEASE AND THE ALKALINE RIBONUCLEASE INHIBITOR OF MAMMALIAN TISSUES. Kraft, N.; Shortman, Ken; Jamieson, Dana (Walter and Eliza Hall Inst., Melbourne. Cancer Inst., Melbourne). Radiat. Res., 39: 655-8(Sept. 1969).

The effects of whole body x-irradiation and corticosteroid administration on the ribonuclease system of mouse and rat thymus and liver are reported. The total levels of alkaline and acid ribonuclease, the level of the alkaline ribonuclease inhibitor and the level of alkaline ribonuclease in a free or active state have all been measured. The approach used emphasized the importance of enzyme and inhibitor balance in determining the actual amount of alkaline ribonuclease free to act in the tissue homogenates. In the first hours after irradiation of mice with 400--900 rad, there was no change in the total levels of alkaline ribonuclease or acid ribonuclease in the thymus. However, the inhibitor was partially inactivated, leading to an increase in the amount of alkaline ribonuclease in an active state. In the more radioresistant liver, the changes were much smaller. Inhibitor inactivation preceded cell destruction, was dose dependent and preventable by a radioprotective drug. Cortisone injection did not produce a comparable effect. A similar change could be produced in rat thymus, but only with relatively high radiation doses. The conclusion was that ribonuclease activation, mediated by destruction of the labile inhibitor, could be a step in radiation injury to mouse thymic lymphocytes but was unlikely to be important in the rat. The activation of a broad spectrum of lytic enzymes by inhibitor destruction should be further investigated as a mechanism of radiation injury. (auth)

45658 THE SYNTHESIS OF DEOXYRIBONUCLEIC ACID AND NUCLEAR PROTEINS BY RAT HEPATOMA CELLS IMMEDIATELY AFTER GAMMA IRRADIATION. Gronow, M.; Todd, P. (Oxford Univ.). Radiat. Res., 39: 705-15(Sept. 1969).

Rat hepatoma cells were irradiated with 1000 rads of gamma radiation in vivo 7 days after intraperitoneal inoculation. Cells were removed immediately after exposure and incubated in medium containing radioactive amino acids or radioactive thymidine. Incorporation of these precursors was monitored for the first half hour, during which DNA and nuclear proteins were normally synthesized at a constant rate. The incorporation of radioactive thymidine into DNA after 1000 rads was about half that found in unirradiated cells, and the incorporation of amino acids into histones and urea-soluble nuclear proteins was unaffected during the first half hour. The presumed normal relationship between DNA synthesis and nuclear protein synthesis appears not to be maintained in irradiated ascites tumor cells. (auth)

45659 SPECTROPHOTOMETRIC CHARACTERIZATION OF DNA AFTER IRRADIATION IN VIVO. V. FRACTIONATION OF DNA EXTRACTED FROM THE LIVER OF NORMAL AND IRRADIATED RATS ON A METHYLATED ALBUMIN COLUMN. Furnica, Maria (Institutul Oncologic, Bucharest). Stud. Cercet. Biochim., 11: 377-84(1968). (In Rumanian).

The DNA extracted from the liver of rats 10 days after irradiation with 900 R was fractionated on a column of methylated albumin adsorbed on kieselgur (MAK). In elution with 0.4M to 0.9M NaCl, normal DNA was separated into 4 fractions, while the irradiated DNA gave 5 main fractions. The new fraction of DNA that appeared in the irradiated rats was eluted with 0.5M NaCl and represented 1/5 of the total DNA content. Normal or irradiated DNA, subjected to thermal denaturation and then fractionated on MAK, was separated into the same number of fractions as before denaturation: 4 fractions of normal DNA and 5 fractions of irradiated DNA. A study of properties of the different heat-treated (90°C for 10 min) DNA fractions eluted from the MAK column showed that the fractions I, IV, and V, representing 37% of the irradiated DNA, are heat resistant. Fractions I and III from the irradiated DNA were resistant to the action of pancreatic DNAase. The new fraction of DNA that appeared after irradiation (fraction IV) was not resistant to denaturation. (BBB)

45660 EFFECTS OF UV- AND X-RAYS ON HISTONES IN VIVO AND IN VITRO. Siebert, W.; Glubrecht, H. (Gesellschaft fuer Strahlenforschung, Munich). Biophysik, 6: 19-24(1969).

Histones were isolated by acid extraction from Chinese hamster ovarian tissue culture cells and investigated by means of an amino acid analyzer. Irradiation was performed with a low pressure mercury lamp (2537 A) or with 30 kV x-ray bremsstrahlung either of the tissue culture cells before extraction or of the isolated histones in aqueous solution. Both types of radiation affected mainly the amino acids tyrosine, phenylalanine, and histidine in the in vitro experiments. After x irradiation in vivo comparable doses were without effect. Ultraviolet irradiation in vivo led to a decrease of tyrosine and phenylalanine in the in vitro experiments, but in contrast to this finding to an increase of histidine concentration. A hypothetical explanation of these results is attempted. (auth)

45661 URINARY EXCRETION OF CATECHOLAMINES IN PATIENTS WITH ARTERIAL HYPERTENSION AFTER RADON INHALATIONS FROM SWIERADOW SPRINGS. Szczeklik, E.; Lukasik, S.; Halawa, B.; Rog-Malinowski, M.; Lukasikowa, W. (Research and Therapeutical Center, Swieradow, Poland. Medical Academy, Wroclaw. Province Cardiological Dispensary, Wroclaw). Pol. Med. J., 7: 1293-7(1968).

Translated from Pol. Tyg. Lek., 23: No. 13(1968).

Urinary excretion of catecholamines following Świeradów radon inhalations was studied in 19 patients with arterial hypertension and in 15 patients with normal blood pressure. Increased excretion was marked in normotensive patients and was less evident in patients with arterial hypertension. These findings suggest that the function of the medullary part of adrenals or of the sympathetic nervous system may be influenced by radon inhalations. The present studies do not permit evaluation of whether the increase of urinary catecholamines following radon inhalations is connected with the general hypotensive effect of treatment in Świeradów. (auth)

45662 INFLUENCE OF CHLORAMPHENICOL ON THE CAPACITY OF X-RAYS TO INDUCE SYNTHESIS OF COLICIN D IN THE STRAIN OF E. COLI CA-23. Gumenyuk, V. A. (Central Inst. of Post-Graduate Students, Moscow). Byull. Eksp. Biol. Med., 68: No. 7, 61-3(July 1969). (In Russian).

The influence of chloramphenicol on roentgenologically induced synthesis of colicin D in the strain of E. coli CA-23 (D) was investigated. He shows that cultivation of colicinogenic bacteria with chloramphenicol (100 μg/ml) for 10 minute periods to irradiation leads to increased inductive capacity of X-ray irradiation. The effect is reversely proportional to the time of preliminary incubation with the antibiotic. Addition of chloramphenicol to induced cells decreases the induction effect. The degree of inhibition depends on the time of cultivation with antibiotic and is more marked when it is added immediately after irradiation. (auth)

45663 INFLUENCE OF THE ULTRA-HIGH-FREQUENCY ELECTROMAGNETIC FIELD ON THE CARBOHYDRATE METABOLISM IN THE BRAIN OF RATS. Mishchenko, L. I. (Research Inst. of Labor Hygiene and Professional Diseases, Kharkov). Byull. Eksp. Biol. Med., 68: No. 7, 56-8(July 1969). (In Russian).

Various nonthermogenic tensions of the electromagnetic field with a frequency of 48 kilocycles in the rat brain tissue produce increase of the lactic and pyruvic acids and decrease the glycogen content. The degree depends on the field tension and the duration of action. A month after cessation of the action of the electromagnetic field of intensity of 800 V/m the titer of the lactic acid in the rat brain does not revert to the normal. (auth)

45664 THE BEHAVIOR OF C-REACTIVE PROTEIN DURING ENDOLYMPHATIC AND PERCUTANEOUS RADIOTHERAPY OF MALIGNANT LYMPHOMAS. Klemm, D. (Univ., Freiburg i. B.). Klin. Wochensch., 46: 1310-11(Dec. 15, 1968). (In German).

The formation of C-reactive protein was studied after treatment of 12 patients who had malignant diseases with involvement of the retroperitoneal lymph node region with five to 10 4000 R doses of ^{60}Co γ irradiation of endolymphatic treatment with 48,000 to 28,000 R of ^{131}I. After ^{131}I treatment there was a temporary rise in C-reactive protein concentration, but after ^{60}Co irradiation the C-reactive protein concentration fell progressively. The behavior of the C-reactive proteins seemed to vary with the general effectiveness of the irradiation treatments, and behaved like the acute phase proteins of the α_1 and α_2 fractions of human serum. (BBB)

45665 MOLECULAR BASES OF PHOTOREACTIVATION. Schuster, Heinz. Curr. Top. Microbiol. Immunol., 47: 40-68 (1969). (In German).

Photochemical effects of uv irradiation at wavelengths from 2500 to 2600 on DNA in microorganisms and viruses, and the photoreactivation recovery process were described and discussed. The primary photodimerization products produced by uv irradiation of the DNA molecule included thymine-thymine, thymine-cytosine, and cytosine-cytosine dimers. The dimerization of adjacent pyrimidine bases located in a DNA double helix proceeded considerably more readily than those between bases in adjacent helices. In these there was cross-linking of the 2 DNA filaments. There were 4 stereoisomeric forms of pyrimidine dimers formed after uv irradiation of thymidine or thymidylic acid. After uv irradiation of 2-chain DNA only the cis-syn-thymine dimers were formed. After uv irradiation of tobacco mosaic virus one protein subunit was formed bound to each RNA molecule. The binding did not involve a covalent bond. Following photoreactivation the intact virus was not photoreactive to uv irradiation, but this was not irreversible. The type of chemical changes in RNA of plant viruses that could be photoreactivated were not ascertained. It was not directly related to formation of uracil dimers from the RNA molecule. (BBB)

45666 METABOLISM OF NICOTINAMIDE-ADENINE DINUCLEOTIDES IN LIVER OF RATS X-IRRADIATED BY 40R. Shalushkova, L. P. (Belorussian State Univ., Minsk. Inst. of Physiology, Minsk). Vestsi Akad. Navuk BSSR, Ser. Biyal. Navuk, No. 3, 118-22(1969). (In Russian).

The metabolism of nicotinamide-adenine dinucleotide in oxidized and reduced forms ($NAD,NADH_2$) was studied in the liver of rats during a single x irradiation with a 40R dose. The content of NAD during irradiation remained the same as in the nonirradiated rats, while the concentration of $NADH_2$ dropped sharply. Disturbances in the content of dinucleotides was observed during determination of the $NAD/NADH_2$ coefficient. The activity of $NADH_2$ oxidase was studied in order to determine variations in the metabolism of coferments, Nicotinamide injections into animals 1 hr before exposure compensated for the loss of NAD inhibiting NADase and increasing individual synthesis of NAD. (R.V.J.)

45667 EFFECT OF ULTRAVIOLET IRRADIATION ON DNA METABOLISM OF EUGLENA GRACILIS. Gibor, A. (Univ. of California, Santa Barbara). J. Protozool., 16: 190-3(Feb. 1969).

Some strains of E. gracilis when irradiated by a slight dose of uv light lose their ability to develop chloroplasts. Such irradiated cells can be grown heterotrophically to become permanently bleached clones. To investigate the bleaching phenomenon, the effects of bleaching doses of uv light on ^{32}P incorporation into the DNA of Euglena were studied. Operation of a DNA repair mechanism was investigated by comparing the ^{32}P incorporation into DNA of nondividing cell suspensions with and without uv irradiation and also following photoreaction of the uv damage. A.G.E. germicidal lamp was used for uv irradiation. Results indicated that the labile DNA of Euglena is probably not directly responsible for the ability of the cells to develop chlorophyll. Increasing doses of uv light above that required for 100% bleaching continued to decrease ^{32}P incorporation into DNA. After a photoreactivation treatment which restored the ability of the cells to green, they nevertheless still had reduced DNA synthesis. A uv-bleached clone was still sensitive to bleaching doses of uv light which caused further inhibition in ^{32}P incorporation into DNA. (BBB)

45668 ESR-STUDIES OF NORMAL AND 5-BROMOURACIL-SUBSTITUTED DNA OF BACILLUS SUBTILIS AFTER IRRADIATION WITH ULTRAVIOLET LIGHT. Koehnlein, Wolfgang; Hutchinson, Franklin (Yale Univ., New Haven). Contract AT (30-1)-2653. Radiat. Res., 39: 745-57(Sept. 1969).

Electron-spin resonance signals are induced, at 77°K and in the presence of water, in B. subtilis DNA in which about 70% of the thymine has been replaced by 5-bromouracil, either by short wavelength ultraviolet light (UV) (2400-4000 Å) or by long wavelength UV (3200-4000 Å). In DNA not containing bromouracil, short wavelength UV induces signals; long wavelength UV produces no detectable signal, indicating a rate of production at least ten times lower than in DNA containing bromouracil. Bromouracil in the DNA suppresses the thymine ESR spectrum to a greater extent than the degree of thymine replacement. The signal induced in DNA containing bromouracil is the same with both ultraviolet radiations, a triplet with g = 2.0023 and an overall splitting of 46 G and a superposed singlet, quite different from that for irradiated bromodeoxyuridine, or a nucleoside mixture. It is unchanged by substituting D_2O for H_2O. The probable location of the radical responsible for the triplet is on the sugar. In the presence of acetate with the DNA, irradiation produces a quartet, but the additive does not affect the extent to which UV reduces DNA-transforming activity. In the presence of 2% mercaptoethylamine with the DNA, sulfur-type spin resonance signals are seen. (auth)

45669 GROWTH OF HEN ERYTHROCYTE NUCLEI UNDERGOING REACTIVATION IN HETEROKARYONS. Bolund, L.; Darzynkiewicz, Z.; Ringertz, N. R. (Karolinska Institutet, Stockholm). Exp. Cell Res., 56: 406-10(Aug. 1969).

In heterokaryons formed by fusing hen erythrocytes with human HeLa cells, the erythrocyte nuclei undergo a reactivation process. This process is associated with marked alterations in the physicochemical properties of the chromatin and a dramatic increase in nuclear volume and dry mass. The present investigation shows that these changes take place also if the erythrocyte nuclei are rendered incapable of RNA synthesis by uv-irradiation before cell fusion. It is suggested that the nuclear growth is due mainly to a massive influx of human proteins from the cytoplasm of the hybrid cell. The redistribution of protein from the cytoplasm into the erythrocyte nuclei may be linked to the altered properties of the DNP-complex. (auth)

45670 REDISTRIBUTION OF K^+ IN CLEAVING EGGS OF A FISH MISGURNUS FOSSILIS. Beritashvili, D. R.; Kvavilashvili, I. Sh.; Kafiani, C. A. (Inst. of Molecular Biology, Moscow). Exp. Cell Res., 56: 113-16(July 1969).

In cleaving eggs of loach, a redistribution of K^+ occurs that leads to K^+ ion accumulation in the embryo (blastoderm) at the expense of yolk. Na^+ content of embryos does not increase. As a result, a significant rise in K^+/Na^+ ratio occurs in embryos, that reaches a constant value by the mid-blastula stage. This occurs also during the cleavage of x-irradiated eggs suggesting that K^+ redistribution is independent of nuclear genetic function. Ionic composition of embryos is maintained by an active, energy-linked mechanism that apparently involves a (Na^+-K^+) ATPase since ouabain (a specific inhibitor of (Na^+-K^+) ATPase of membranes) causes a loss of K^+ from the cells. K^+ ion accumulation and the attainment of a constant K^+/Na^+ ratio are correlated with a drop in mitotic index and with the onset of RNA synthesis in the cell nuclei. The results are consistent with the proposal that the increase in K^+/Na^+ ratio may play a part in switching over the nucleic acid synthesis from replication to transcription path. (auth)

45671 INVESTIGATION OF THE HEMOGLOBIN HETEROGENEITY IN IRRADIATED ANIMALS. Starodub, M. F. (Inst. of Physiology, Kiev). Fiziol. Zh., Akad. Nauk Ukr. RSR, 15: 553-5(July-Aug. 1969). (In Ukrainian).

Studies on the heterogenic nature of hemoglobin in white male rats irradiated with lethal doses of x radiation and fast neutrons revealed that irradiation induced damage in the fractional components of the hemoglobin. The fast neutrons produced a much stronger effect than the x irradiation. (R.V.J.)

45672 PRODUCTION OF FREE RADICALS IN ORGANIC SOLIDS BY THERMAL HYDROGEN ATOMS. Jensen, Harald; Henriksen, Thormod (Norwegian Radium Hospital, Montebello). Acta Chem. Scand., 22: 2263-76(1968).

Several amino acids and nucleic acid bases were exposed, in the solid state, to the products in a hydrogen gas discharge system. These discharge products include thermal hydrogen atoms as well as high-frequency uv light. It was found that the vacuum uv light produced radicals similar to those induced by ionizing radiation in most substances. The uv light was reduced by introducing bends in the discharge system. The exposed substances can be divided into three groups. In the first group, that includes substances such as glycine, alanine, and glycyl-glycine, the radicals were formed by the uv light. In the second group, containing leucine, penicillamine, and malonic acid, both the uv light and the thermal hydrogen atoms contributed to the radical formation. Finally, in the third group, containing thymine and uracil, the free radicals were formed by the thermal hydrogen atoms. Thermal hydrogen atoms produced radicals either by abstracting a hydrogen atom from a saturated molecule or by adding a hydrogen atom to an unsaturated carbon atom. Since the thermal hydrogen atoms have a limited range in the exposed crystallites, the radicals were formed and trapped in a surface layer only. Calculations based on dipolar broadening indicate a thickness of approximately 0.2 to 0.3 μ for this surface layer. This distribution of radicals makes them readily accessible to diffusible gases and a pronounced oxygen effect was observed. (auth)

Immunology

Refer also to abstracts 45695 and 45848.

45673 (ANL-7535, pp 99-100) MODIFICATIONS OF ANTIBODY FORMATION. Taliaferro, William H.; Taliaferro, Lucy Graves (Argonne National Lab., Ill.).

Radioinduced modification of the Forssman gamma 1 anamnestic hemolysin response was examined in over 700 rabbits. This study parallels a similar study of the initial response to the same antigen. Both studies were based on unirradiated controls, an unmodified initial response following one intravenous injection of a

standardized antigen, and an anamnestic response following a similar procedure 1.5 to 2 months later. Eighty groups of rabbits were reinjected with sheep red blood cells at intervals extending from 2 days before through 6 months after whole-body x irradiation. Blood was obtained several times a week for a month or more and tested for the 50% hemolysin end point. The anamnestic response was enhanced when antigen was given before x-ray doses of 50, 100, and 300 R, but not by doses of 500 and 700 R. Hemolysin-forming capacity was rapidly lost within 4 to 8 hr, especially when antigen was given after the three largest doses of x radiation. The response was not repressed by the smallest dose, but was increasingly depressed with increase of dose after the four higher doses. Depression was most marked when antigen was given 1 to 2 days after irradiation. Recovery from radioinduced injury gradually occurred, the mean peak titers increasing with time after irradiation. In rabbits which received the largest radiation doses the normal titers were not obtained until 6 months after irradiation. It was concluded that the additional antibody-forming cells, induced by the initial injection and present at reinjection, acted as a buffer against the depressing effects of low doses of irradiation but were inadequate against the higher doses. (M.M.B.)

45674 (ANL-7535, pp 101-2) CHANGES IN THE IMMUNE RESPONSE OF BCF$_1$/Anl MICE WITH AGE. Miller, Marietta; Jaroslow, Bernard N. (Argonne National Lab., Ill.).

Preliminary experiments are described which measure the effects of age on the primary immune response (19S and 7S) in mice varying in age from 6 to 180 days. These experiments are part of a program which will include investigation of the effects gamma and neutron radiations have on the immune responses. The capacity to produce 19S hemolysin-forming cells was very low in 6-day-old mice, increased rapidly until 28 days, and increased more slowly through 180 days. The 7S response paralleled the 19S response but was later. No clear difference was demonstrated between the sexes. (M.M.B.)

45675 THE COMBINED EFFECT OF 6-AZAURIDINE AND IRRADIATION IN VIVO AND IN VITRO. V. PRIMARY AND SECONDARY ANTIBODY RESPONSE IN MICE PRETREATED WITH REPEATED 6-AzUR APPLICATION AND IRRADIATION. Grozdanovic, J.; Truxova, G.; Vich, Z. (Health Inst. of Uranium Ind., Pribram, Czech.). Neoplasma, 16: 225-9(1969).

The effect of the combined application of γ irradiation and 6-azauridine on the primary and secondary antibody response in mice immunized by human erythrocytes and bovine albumin, and on homotransplantation immune response to skin graft was studied. Single application of 6-AzUR did not exert any influence on the primary, as well as on the secondary antibody response in mice. Total irradiation with 150 R decreased slightly antibody titre in primary reaction, providing the antigen had been applied in the first days following the irradiation. Having been applied after four months, antibody response was the same as in the control. The application of 6-AzUR two hours prior to the irradiation resulted in significant inhibition of primary antibody response, and 6-AzUR application following the irradiation influenced the reaction only slightly. Secondary response did not differ after the experimental treatment from that of the controls, but the simultaneously occurring primary reaction was inhibited again by 6-AzUR when applied prior to the irradiation. In homotransplantation immune reaction no changes were observed. (auth)

45676 THE KINETICS OF INDUCTION OF IMMUNE TOLERANCE IN X-RAYED RABBITS. Nachtigal, D. (Weizmann Inst. of Science, Rehovoth, Israel). Int. Arch. Allergy Appl. Immunol., 36: 89-90(1969).

A study on the kinetics of immune tolerance induction employed rabbits given sublethal x irradiation. After irradiation the animals were treated with human serum albumin (HSA) which rendered them specifically tolerant to HSA after their complete recovery from radiation injury. Tolerance could be induced in this system with very small amounts of antigen, within the range of small immunizing doses in the nonirradiated controls. However, this low-level antigen treatment was effective in inducing tolerance only if an appropriate HSA injection schedule was used. Thus, antigen had to be given in multiple subdoses spread over the first 8 weeks after irradiation, during which time the animals recovered from immunologic radiation injury and regained overall immune competence. Moreover, antigen treatment was equally effective even when started as late as 4 weeks after irradiation, so that HSA treatment was confined to the second month of immune recovery only. The resulting state of tolerance was stable and persisted during the life-span of the animals, which were rechallenged every 6 months. Study of the cell-depleted lymphoid organs of some irradiated rabbits during the tolerance induction period demonstrated that the immune recovery was much slower than the histological lymphoid recovery. In fact, at 4 weeks after irradiation when tolerance induction could still be started, the formerly depleted lymphoid organs showed good cellular repopulation, demonstrating that neither lymphoid depletion nor lymphoid immaturity was a prerequisite of tolerance induction. The macrophage may be the critical cell in tolerance induction. (BBB)

45677 LYMPHOCYTES AND IMMUNOGLOBULINS. Sell, S. (Univ. of Pittsburgh); Asofsky, R. Progr. Allergy, 12: 86-160 (1968).

The relation between antibody-mediated immune reactions and cell mediated immune reactions, and the relation between immunoglobulins and lymphocytes are reviewed (with 544 references), including information on the effects of radiation on immunogenesis. Nineteen reports on the effects of irradiation upon immune processes are referred to. Following irradiation, there is a rapid loss of lymphocytes from the peripheral blood. Antibody production continues when the lymphocytes counts are at a minimum, but the loss of ability to induce a primary response to antigen and the lowering of blood lymphocytes after irradiation both occur within 24 to 48 hr and require about 30 days to recover, suggesting a similar effect of radiation on cellular and antibody-mediated responses. However, it was reported that delayed hypersensitivity may develop in guinea pigs and rabbits that have received sufficient irradiation to eliminate or greatly reduce primary antibody responses. Higher doses of radiation will also abolish the ability to induce delayed type reactivity and very large doses may destroy both primary and secondary antibody responses, in addition to delayed hypersensitivity. Six reports in which x irradiation of recipient adults was employed to abolish or minimize host response to antigen are referred to, and 3 in which it was used in allogenic transfers, as between rabbits, to prevent rejection of the donor cells by a homograft reaction. Studies in inbred mice showed, moreover, that even in syngeneic transfers, irradiation of recipients permits greater antibody synthesis by transferred cells. In some experiments it was shown that no antibody is synthesized if recipients are not irradiated. This "barrier" to syngeneic transfer is absent at birth, but increases to a maximum at about 2 months of age. Increasing doses of x irradiation progressively diminished this barrier until it was entirely abolished. The use of heavily irradiated recipients increased the sensitivity of expression of immunologic potential in these experiments. It was shown that thoracic duct lymphocytes are part of a constantly recirculating pool of cells, and that rats depleted of lymphocytes by chronic thoracic duct drainage are not able to produce hemolysins to sheet erythrocytes. Furthermore, thoracic duct cells are capable of restoring the response both of drained rats and of rats rendered unresponsive by prior x irradiation. Thoracic duct cells obtained from rats previously immunized with tetanus toxoid or bacteriophage transmitted immunologic memory to x-irradiated recipients. Recent experimental evidence that immunoglobulins or antibodies are present in or on lymphocytes was summarized. (BBB)

45678 INACTIVATION OF COLONY-FORMING ACTIVITY OF EMBRYONIC HAEMOPOIETIC CELLS IN TRANSPLANTATION OF TWO GENETICALLY INCOMPATIBLE DONORS. Vasileiskii, S. S.; Petrov, R. V. (Inst. of Biophysics, Moscow). Byull. Eksp. Biol. Med., 68: No. 7, 86-8(July 1969). (In Russian).

Lethally irradiated mice hybrids F$_1$(C57Bl×CBA) received 1.10^6 to 3.10^6 cells of the embryonic mouse liver of parent strains separately or in mixture. In simultaneous transplantation the number of spleen colonies was decreased as compared to the sum of colonies formed after separate administration of cells of each strain. The index of inactivation of the number of colony-forming units in various experiments varied between 14 and 69%. (auth)

45679 EFFECT OF IONIZING RADIATION ON HEMOLYTIC PLATELET-FORMING SPLEEN CELLS DURING USE OF CERTAIN CHEMICAL RADIOPROTECTORS. Soumerska, T. (Inst. of Radiology and Radiation Hygiene, Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 105-8(1969).

The effects of the radioprotective substances β-mercaptoethylamine and 5-hydroxy-tryptamine on the reduction of the radiation dose in sublethally irradiated regions in mice were studied. The mice were γ-irradiated (^{60}Co) to determine the effects of sublethal doses on the hemolytic plaque-forming cells. The radioprotectives were administered after irradiation and before immunization, 3 days after immunization (during antigen stimulation), and 4 days after immunization (during active antibody formation). The specificity of each radioprotectant toward a given phase in the development of immunocompetent cells is discussed. (E.R.B.)

Ecology

Refer also to abstracts 45213 and 45883.

45680 (BMI-171-119) EVALUATION OF PHOTOGRAMMETRIC TECHNIQUES FOR CENSUSING SEA OTTERS. Amchitka Bioenvironmental Program. Stephan, Joachim G. (Battelle Memorial Inst., Columbus, Ohio). July 22, 1969. Contract AT-(26-1)-171. 18p. Dep. CFSTI.

Tests were conducted on Amchitka Island, Alaska, between September 18 and October 8, 1968, to permit a comparison of visual and photographic censusing of sea otter (and other) populations. Although the test schedule was held to an unexpectedly narrow time span, valuable data and experience were gained. An evaluation of the photography obtained over Amchitka led to the following conclusions: Sea otters may be readily distinguished in aerial photographs by a skilled photo interpreter. Censusing through aerial photography in marginal-weather areas such as Amchitka may best be performed using the Ektachrome Infrared Aero Film Type 8443. When correctly exposed, this film renders the sea otters black against a background of a bright, almost flaming, red when they are resting in the kelp beds surrounding the island. When in the water, the animals appear black against a light-blue ocean in silhouettes very characteristic of the sea otter. Photo counts in this test exceed visual counts by about 50% in areas where there are many animals lying in the kelp beds. Stereo photography provides an advantage, especially when marginal photography is viewed. Large-format photography (9 × 9-inch photos) is best suited for photographic recording of large areas. Oblique forward photography should be used with the camera axis depressed no more than 30 degrees to avoid absorption of the infrared portion of the light. Absorption of too much light in the ocean areas renders the water as dark blue, green, or even black, thus making it unusable for detection of sea otters in the water. Future large-scale photo censusing should be conducted using a forward-mounted, oblique configuration of a weatherproof container enclosing the K-17B camera with a 12-inch lens and a vacuum pump. This box should be constructed so as to permit easy installation by bracket fasteners. The camera should be suspended within the box so as to reduce any vibration to a minimum. (auth)

45681 (CONF-690604-(Abstr.)) 3rd ANNUAL CONFERENCE ON TRACE SUBSTANCES IN ENVIRONMENTAL HEALTH, MEMORIAL UNION, UNIVERSITY OF MISSOURI, COLUMBIA, MISSOURI, JUNE 24-25-26, 1969. (Missouri Univ., Columbia). 36p.

Abstracts of papers within the scope of NSA are: "Factors Influencing Radiostrontium Absorption in Man" and "Scanning Youth for Cystic Fibrosis." The chemistry of trace elements in soils, trace elements in human tissues, trace element pollution of air and water, methods for analysis of trace elements, and natural toxic agents in plants are discussed in remaining abstracts. (H.L.W.)

45682 (NVO-40(Rev.2), pp 301-11) BIOENVIRONMENTAL SAFETY. Fuller, R. G.; Martin, W. E. (Battelle Memorial Inst., Columbus, Ohio).

The bioenvironmental safety program of Columbus Laboratories of Battelle Memorial Institute deals with the potential impact of such shot-related perturbations as air blast, ground motion, and radionuclide release on the ecosystem. In addition it considers the ecological consequences of construction, site preparation, and drillback activities associated with the execution of the detonation. Bioenvironmental safety studies are directed toward four principal objectives: prediction of the potential effects of any given detonation on the surrounding ecosystem and, via indirect routes, on humans; recommendation of courses of action to avoid or to minimize harmful test consequences; post-event documentation and evaluation of the ecological effects, if any, of the test; and recommendation of corrective action if harmful consequences ensue. The detonation of any nuclear device will inevitably disturb the ecological system to some degree, just as will the building of a highway, or the damming of a river. The responsible approach in planning a nuclear event is to estimate, in advance of the event, what the significant ecological consequences are likely to be. By reference to such an assessment, program planners are able to weigh any predicted detrimental effects against the benefits to be gained and to determine objectively whether the detonation can be accomplished without injury to people, either directly or indirectly, and without unacceptable damage to the ecological system. Objective prediction of the ecological effects and the indirect radiological health hazards, if any, of any test under consideration therefore becomes a primary goal of the bioenvironmental safety studies. (C.H.)

45683 (PNE-R-3) BIOENVIRONMENTAL SAFETY SURVEY AND EVALUATION. PRE-EVENT: PROJECT RULISON. Fuller, R. Glen (Battelle Memorial Inst., Columbus, Ohio). July 28, 1969. Contract AT(26-1)-171. 20p. Dep. CFSTI.

An ecological survey of the area around the Project Rulison site was made to ascertain the seasonal distribution of range livestock and wild game in the area. This information is required to plan courses of action in the unlikely event of accidental release of radionuclides. The survey was also aimed at identifying any potential adverse consequences of the project for which preventive or remedial action may be needed. (auth)

45684 RADIOECOLOGICAL SURVEILLANCE OF THE WATERWAYS AROUND A NUCLEAR FUELS REPROCESSING PLANT. Sax, N. I. (New York State Dept. of Health, Albany); Lemon, Paul C.; Benton, Allen H.; Gabay, Jack J. Radiol. Health Data Rep., 10: 289-96(July 1969).

A 3-year study of the aquatic ecosystem around a nuclear fuels reprocessing plant, located in western New York State, was conducted to find and evaluate natural indicators of environmental contamination. The study covered preoperational and early post-operational phases. The ecological vectors selected for study were algae, silt, and fish, all from Cattaraugus Creek and its tributaries. Samples were collected at several points upstream and downstream from the plant effluent and quantitatively analyzed by gamma-ray spectrometry. All vectors analyzed indicated process of uptake and concentration of ^{106}Ru-Rh, ^{137}Cs, ^{134}Cs, ^{95}Zr-Nb, and sometimes ^{60}Co. In addition, the concept of using natural indicators not native to the streams under study was tested by translocating fresh water clams from Chautauqua Lake, 60-miles southwest of the site, and placing them in the streams around the plant. The clams not only thrived in their new environment but upon analysis showed definite interaction by concentration of the above radioisotopes with the shells showing approximately twice the radioactivity of the soft parts of the clams. This concept might prove to be a sensitive indicator of environmental contamination. (auth)

45685 THE STRUCTURE OF TROPICAL FORESTS IN PANAMA AND COLOMBIA. Golley, F. B.; McGinnis, J. T.; Clements, R. G.; Child, G. I.; Duever, M. J. (Univ. of Georgia, Athens). Bioscience, 19: 693-6(Aug. 1969).

Identification of various ecosystems in Panama and Colombia was made as part of a study of the feasibility of use of nuclear explosives for excavation of a sea-level canal between the Atlantic and Pacific Oceans. The objective of the terrestrial ecology program was to determine the routes to man and the uptake of radionuclides by man in terrestrial ecosystems. Analysis of the movement of radioisotopes through terrestrial ecosystems required information on the concentration and cycling of stable elements. Since radioactive tracers could not be used and present fallout levels in the ecosystems of interest were very low, it was necessary to follow the cycle of the stable elements. For the study of cycling in the terrestrial ecosystems, information on the kinds of ecosystems, on their biomass, and on mineral standing crops was required. Identification of the major terrestrial ecosystems was made by survey of the literature and reconnaisance trips across the canal survey routes in the Darien and San Blas Provinces in Panama and the Department of Choco in Colombia. The general vegetation groupings that were probably functionally different in mineral cycling were determined. The dominant vegetation is forest with little land area under cultivation. Mineral assays of various plant types are reported. (BBB)

45686 ELEMENTAL AND HYDROLOGIC BUDGETS OF THE PANAMANIAN TROPICAL MOIST FOREST. McGinnis, J. T.; Golley, F. B.; Clements, R. G.; Child, G. I.; Duever, M. J. (Univ. of Georgia, Athens). Bioscience, 19: 697-9(Aug. 1969).

Some aspects of the movement and storage of stable elements through hydrologic and elemental functions of the tropical moist forest ecosystem are examined in terrestrial ecology studies in the areas of Panama and Colombia as a part of the Interoceanic Sea-Level Canal Feasibility Study. A mature forest stand was harvested in the Darien Province of eastern Panama near Santa Fe during 1967. The stable metallic element concentrations in organic matter, soil, and rainfall samples from terrestrial communities were determined. The movement and storage of stable elements in the tropical moist forest are conceived to fit a systems diagram which is illustrated. (BBB)

45687 SOCIAL STRUCTURE OF SMALL MAMMAL POPULATIONS AT THE NATIONAL REACTOR TESTING STATION, IDAHO. Speth, Rudolph Lynn. Provo, Utah, Brigham Young Univ., 1969. 149p.

Thesis.

This investigation examined the social structure of four species of small mammals (Perognathus parvus (Peale), Reithrodontomys megalotis (Baird), Peromyscus maniculatus (Wagner), Dipodomys ordi (Woodhouse)) at the National Reactor Testing Station (NRTS) in Idaho. An understanding of the social structure provides ecological clues concerning the integration of interactions, reproduction, distributions, densities, and diel activities for not only one animal and species, but for a complex of animals interacting with each other. Population data were collected during the summers of

1966 and 1967 from an 8 ha grid using three different trapping periods: 28 consecutive days of trapping, seven days of intensive night trapping and 3.5 months of intermittent trapping. A total of 414 animals recaptured 3,032 times were used in the analyses of population parameters. Vegetation, home range, density, distribution, activity and the probability of interaction among the species were intensively studied. The vegetation and three of the four animal species on the trapping grid were randomly distributed. Adult D. ordi males had a clumped distribution. The density of R. megalotis and P. maniculatus decreased nearly to zero from 1966 to 1967 while the density of P. parvus was relatively unchanged. This decrease was followed by an increase in juvenal P. parvus. Home range parameters were estimated for each age, sex, and species class, and were used to establish a new method of estimating probable interaction among animals which were then compared to an existing method. Diel activity patterns were determined from the trapping records of the three study periods. These patterns suggested the alternate use of space by males and females, and showed a decrease in activity of females when they were reproductively active and when unfavorable environmental conditions existed. Spatial distribution of animals is vital to the interpretation of population parameters and new methods of estimating randomness are seriously needed. It is evident that densities necessitate and examination of home range, distribution, interaction, and behavior before their meaning is clearly understood. Probabilities of interaction provide a method of examining the spatial relationship between animals. There was a positive correlation between the number of interactions and density. The social structure is a dynamic process of events that continually adjusts in time and space. During this investigation there was a complete change in the social structure of small mammals; a decrease of R. megalotis and P. maniculatus nearly to zero in 1966 was followed by a large increase of P. parvus juveniles and a subsequent decrease of adults in 1967. Factors such as the environment, competition, and interaction examined with the analyses of home range, spatial distribution, density, and probable interaction were, in part, responsible for the change in social structure of the species investigated at the NRTS. (Disser. Abstr.)

Genetics and Cytogenetics

Refer also to abstracts 45859, 45955, and 45969.

45688 (AECL-3334) MUTATION AND REPAIR IN EUGLENA GRACILIS. Olson, A. O. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1969. 21p. (CONF-690703-4; SM-121/4). Dep. CFSTI. CAN $1.00.

From Symposium on the Nature, Induction, and Utilization of Mutations in Plants, Pullman, Wash.

The ability of the Euglena nucleus to survive mutagenic treatments that cause permanent apochlorosis suggests that the nucleus must possess a much more efficient repair system than do the chloroplasts. An excision mechanism capable of removing nucleic acid bases modified by N-methyl-N-nitroso compounds (i.e., N-methyl-N-nitro-N-nitrosoguanidine) was demonstrated. From studies with light synchronized cells, and with extracted chloroplasts, it appears that excision enzymes are not present in Euglena chloroplasts. (auth)

45689 (ANL-7535, pp 1-3) GENETICAL AND PHYSIOLOGICAL STUDIES OF A LARGE-CELL RADIATION-RESISTANT STRAIN OF ESCHERICHIA COLI. I. GENETIC ANALYSIS. Kvetkas, Marilyn J.; Krisch, Robert E.; Zelle, Max R. (Argonne National Lab., Ill.).

A genetic analysis was undertaken to study the basis for the enhanced radioresistance of Escherichia coli P6 compared to its parent, E. coli 82/r. Recombinant analysis and transduction were used for mapping the relevant genes. Results indicated that the characteristic differences between the mutant and parent strains were the pleiotrophic consequences of a single-point mutation. The mutant gene, lar-1, is closely linked to arg G and is located at 61 ± 0.5 min on the linkage map. (M.M.B.)

45690 (ANL-7535, pp 3-5) GENETICAL AND PHYSIOLOGICAL STUDIES OF A LARGE-CELL RADIATION-RESISTANT STRAIN OF ESCHERICHIA COLI. II. PHYSIOLOGICAL STUDIES. Kvetkas, Marilyn J.; Krisch, Robert E.; Zelle, Max R. (Argonne National Lab., Ill.).

Growing Escherichia coli P6 and 82/r at different rates revealed that E. coli P6 cells not only contained more total DNA but also contained approximately twice as much DNA per nuclear body. These data may be interpreted as indicating that mutation of the gene, lar-1, has resulted in a doubling in the DNA complement per nuclear body of E. coli P6 cells. The results from the X-ray experiments suggest that the doubled DNA content per nuclear body may account for the greater resistance of E. coli P6 cells to X-irradiation. (auth)

45691 (ANL-7535, pp 6-7) LETHAL AND GENETIC EFFECTS OF RADIOISOTOPE DECAY IN BACTERIOPHAGES. Krisch, Robert E.; Coombs, Barbara A. (Argonne National Lab., Ill.).

An investigation of the lethal and genetic effects of radioisotope decay in bacteriophages is in progress. Evidence obtained so far is too preliminary to draw firm conclusions. (auth)

45692 (ANL-7535, pp 15-17) PHOTOMUTAGENESIS IN CHEMOSTAT CULTURES OF BACTERIA. Webb, Robert B. (Argonne National Lab., Ill.).

Progress is reported on an investigation of the mechanisms involved in visible light mutagenesis. Escherichia coli B/r/1, try$^-$ was grown in glucose-limited chemostat culture. Streptomycin-resistant mutants occurred in visible light (145 ergs mm^{-2} sec^{-1}) at a rate of 32×10^{-11} mutants/cell/hr compared to the control dark mutation rate of 3.1×10^{-11} mutants/cell/hr. The mutation rates were independent of the growth rate. The rate of mutation resulting in resistance to T5 bacteriophage was 67×10^{-9} mutants/cell/hr at an irradiance of 140 ergs mm^{-2} sec^{-1} over a growth rate range of 0.1 to 0.5 divisions per hr. After irradiation is started there is a delay before the frequency of phage resistant mutants begins to increase. The mean delay of expression in generations of T5 resistances was found for different mutagens. Caffeine gave a delay of 5.4 generations, acridine orange plus visible light 2.1, 254 nm uv 2.3, 330 to 380 nm uv 4.0, and 380 to 750 nm visible light 4.3. The latter three, short and near uv and visible light, resulted in a mean of less than one generation when mutation for streptomycin resistance was measured. A reconstruction experiment in the dark and light did not show any significant selective effects against T5 resistant or sensitive cells. (M.M.B.)

45693 (ANL-7535, pp 17-19) MAMMALIAN GENETICS: DETERMINATION OF THE RADIATION-INDUCED MUTATION RATE FOR SEX-LINKED RECESSIVE LETHALS IN THE MOUSE. Grahn, Douglas; Craggs, Rebecca; Leslie, Wayne P.; Liebel, Jane (Argonne National Lab., Ill.).

Phase one of our efforts to ascertain the radiation-induced mutation rate for sex-linked lethals is nearing completion. This phase has involved the mating of irradiated (or control) males with To/+ females to produce To F_1 females carrying an irradiated or control X-chromosome. This F_1 dam is outcrossed to produce an F_2 family that is analyzed for sex-ratio deviation. The families derived from the irradiated grandsire show a significant increase over controls in the frequency of suspect carriers of new sex-linked lethals. Since we are still unable to isolate a clear-cut lethal mutation, the effect is interpreted as attributable to sublethals or detrimentals whose expression in successive generations may be variable and tend toward the normal. The mutation rate to detrimentals is estimated to be about 7×10^{-6}/R/X-chromosome. (auth)

45694 (ANL-7535, pp 122-3) A KINETIC MODEL OF PHOTOREACTIVATION IN UV-IRRADIATED BACTERIA. Tyler, Sylvanus A.; Dipert, Merlin H.; Davies, David J. G. (Argonne National Lab., Ill.).

Equations describing a "sequential repair" model of photoreactivation and their application to the observed surviving fractions of Escherichia coli WP2 after uv irradiation and subsequent exposure to visible light are presented. (M.M.B.)

45695 (ANL-7535, pp 201-2) THE EFFECT OF CYSTEAMINE ON CHROMOSOMAL ABERRATIONS AND DIVISION DELAY IN CHINESE HAMSTER CELLS. Yu, C. K.; Sinclair, Warren K. (Argonne National Lab., Ill.).

Synchronized Chinese hamster cells were x irradiated at doses of 750 to 3,000 R in the presence of 50 mM cysteamine and at doses of 250 to 500 R without cysteamine. With cysteamine, division delay was markedly reduced at all stages of the cell cycle. G_2 cells were the least protected. The Dose Modifying Factor (DMF) for all stages was between 2 and 3. Cysteamine alone had no effect in delaying division when added at most stages of the cell cycle; however, in early S, this agent induced a division delay of about 1 hr. The total chromosome aberration rate was very much reduced in the presence of cysteamine, with a DMF of 5 to 6. Cysteamine did not markedly change the form of the cytological response during the cell cycle. The DMF was much larger than for division delay and also larger than that found previously for lethality, however. (C.O.)

45696 (ANL-7535, pp 231-5) LETHAL EFFECTS OF LONG WAVELENGTH ULTRAVIOLET AND VISIBLE LIGHT ON CELLS. Webb, Robert B.; Lorenz, John R. (Argonne National Lab., Ill.).

Results with Escherichia coli suggested that different mechanisms, perhaps different chromophores, may be responsible for lethal and mutagenic effects in the near uv and visible ranges. It has been found previously that the spectral region between 420 nm and 480 nm is as efficient for mutagenicity as the region be-

tween 350 nm and 390 nm. This result is in marked contrast to the lethal responses in these two wavelength ranges in which 365-nm radiant energy is 50 to 100 times more efficient than the 390- to 750-nm range. It is conceivable that the chromophore responsible for mutagenesis in the long wavelength ultraviolet and visible ranges is destroyed by the high irradiances required for inactivation. A different chromophore, not destroyed by high irradiances, may produce the lethal effects observed. (auth)

45697 (BNL-13879) INDUCED MUTATION RESEARCH IN PLANT BREEDING. Briggs, Robert W. (Brookhaven National Lab., Upton, N. Y.). [1969]. 8p. (CONF-690711-1). Dep. CFSTI.

From Symposium of Peaceful Uses of Atomic Energy, Kinshasa, Congo, Africa.

Induced mutation research has played a role in many plant breeding projects, i.e., many improved varieties of crops were developed as a result of mutation breeding programs. The number of varieties being produced by using the mutation breeding technique is becoming quite large. An objective of plant breeding is to develop better plant varieties that will contribute to an improved agricultural industry and to greater comfort and health of many people through better food and fiber crops. Conducting mutation induction experiments and mutation breeding can help to bring about this objective. (auth)

45698 (COO-697-19) GENETIC EFFECTS OF IRRADIATION IN RATS. Technical Progress Report, 1968-69. Chapman, A. B. (Wisconsin Univ., Madison. Dept. of Genetics). Contract AT(11-1)-697. 5p. Dep. CFSTI.

Avoidance learning was studied in irradiated and unirradiated lines of rats. Radioinduced mutations were present in the irradiated lines even though no irradiation had been given for a number of generations. The apparatus used to study the learning behavior was a shuttle box; a green light was used for the conditioned stimulus and an electric shock was used for the unconditioned stimulus. Photocells in the compartment walls monitored the position of the rat in the shuttle box and indicated the occurrence of an avoidance or escape response, defined as movement, by the rat during a trial, from one compartment to the other. Two criteria were used to measure learning. One was the percent of avoidances in each session, a session being a group of 40 consecutive trials given on one day, and the second was the latency, which is the interval between the onset of the conditioned stimulus and the termination of the trial. Results of these experiments are as yet incomplete. (H.L.W.)

45699 INTERACTION OF CHROMATID BREAKS INDUCED BY NITROSOGUANIDINE IN COMBINATION WITH SOME RADIOMIMETICS AND X RAYS. Kaul, B. L. (Max-Planck-Institut fuer Zuechtungsforschung, Cologne-Vogelsang, Ger.). Chromosoma, 26: 469-74(May 29, 1969).

The pattern of chromosome breaks produced by ionizing radiation is different from that produced by radiomimetic chemicals. While radiations have a random effect, breaks produced by chemicals (e.g., alkylating agents) are nonrandom and tend to be localized in specific chromosomes or parts of a chromosome, preferentially in the heterochromatic regions. Lateral roots of Vicia faba were treated with nitrosoguanidine (NG) in combination with three known radiomimetics, ethylmethane sulfonate (EMS), 2,3-diepoxybutane, ethylenimine, and with x rays to determine whether the breaks produced by NG could interact with chromosome breaks produced by the other agents. It was shown that NG-induced breaks fully interact in production of isochromatid breaks and interchanges with diepoxybutane, EMS, and ethylenimine but fail to do so with x rays though the effects were additive. This was interpreted to indicate that NG-produced aberrations have both temporal and qualitative similarities with those of diepoxybutane, EMS, and ethylenimine but not with those induced by x rays. (BBB)

45700 THE EFFICIENCY OF APPLYING IONIZING RADIATION TO REMOTE HYBRIDS IN COTTON BREEDING. Ibragimov, Sh. I.; Tyaminov, A. R. (Inst. of Cotton Breeding and Seed Production, Tashkent). Genetika, 5: No. 8, 64-75(Aug. 1969). (In Russian).

The introduction of wild varieties into the breeding work is required for the solution of the problem of raising the wilt resistance in cotton. The remote hybridization within the species Gossypium hirsutum L. failed to yield desirable results because of the complex character of the segregation in the hybrids. The irradiation of the F_1 and F_2 hybrids between the wild form and the cultivated varieties of cotton at different stages of development of reproductive organs resulted in a very wide spectrum of variations of many characters. Several forms possessing a complex of economically valuable characters were found among the progeny of the irradiated remote hybrids. (auth)

45701 CYTOGENETIC EFFECTS OF FRACTIONATED X-RAY TREATMENT ON THE CULTURE OF EMBRYONIC HUMAN FIBROBLASTS. Bigaliev, A. B.; Lyubimova, T. P.; Tarasov, V. A. (Inst. of General Genetics, Moscow). Genetika, 5: No. 8, 162-71(Aug. 1969). (In Russian).

Fractionated irradiation of human fibroblasts in culture with x rays results in a change of the curve of radiosensitivity of chromosomes, which is probably caused by the response to the fractionation of the x-ray dose of the intracellular system, controlling the conversion of premutational lesions of chromosomes into the fixed form. The introduction of a chemical protector (0.1 M solution of thiourea) prior to irradiation apparently prevents the damage of this system. The character of the change of radiosensitivity to fractionated irradiation at different time intervals between the half-doses is different at various stages of the cell cycle. (auth)

45702 COMPARISON OF THE MUTAGENIC ACTION OF ALKYLATING AGENTS AND GAMMA RADIATION ON ARABIDOPSIS THALIANA. Jacobs, M. (Univ. Libre, Brussels). Radiat. Bot., 9: 251-68(July 1969). (In French).

Effects of three sulfonate esters, a nitrosamine and γ-radiation were compared on the basis of mutation rate, sterility and lethality. The most powerful mutagen was ethyl-methane-sulfonate (EMS), inducing up to 16 percent chlorophyll mutants, followed by methyl-N-nitro-N'-nitrosoguanidine (MNG) 12 percent, methyl-methane-sulfonate (MMS) 7.5 percent γ-radiation 5.5 percent, and butyl-methane-sulfonate 2.3 percent. Increase of mutation frequency can arise from decreased lethality in treated plants. Mutagenic efficiencies compared with toxicity corresponded fairly well to those obtained for induced sterility. The order found was ESM > MNG > MMS > γ > BMS. Comparison of induced sterility to chlorophyll mutation frequency showed a maximal efficiency for EMS, meaning that for the same number of induced mutations, this alkane sulfonate induced less sterility. Relations of mutagenic effects with concentration were linear after irradiation, exponential after MNG or EMS and rather sigmoidal after BMS and MMS. Evidence was obtained of preferential induction of some chlorophyllian phenotype related to the mutagen utilized. EMS induced relatively few albina as compared with γ-rays. Chlorophyll mutation spectra differed not only with the nature of the mutagen but also with experimental conditions, temperature and pH. Genome itself can interfere to preserve or eliminate some mutations. Mean segregation ratios of M_2 chlorophyll mutations were widely lower than 25 percent. Their values, which are an indication of the mutated sector, increased in the direction MMS < γ < MNG < EMS. Analysis of these segregation ratios led to consideration of the occurrence of two or three initials as origins of the generative tissue. Some external conditions can increase the mutation rate. Increased temperature during treatment increased the reactivity of MNG. In the case of EMS, seed presoaking had the same action. Increase of pH of the mutagenic solution resulted in an increase of mutated plants after MMS treatments. Differential sensitivity to EMS appeared in three strains of Arabidopis from different geographical origins. These differences are concerned as much with the mutability as the biological reactions of the treated generation. (auth) (UK)

45703 THE EFFECT OF FRACTIONATED X-RAY DOSES ON THE YIELD OF CHROMOSOME ABERRATIONS IN CREPIS CAPILLARIS. II. IRRADIATION AT THE STAGES G_1, S, AND G_2. Generalova, M. V. (Inst. of Developmental Biology, Moscow). Genetika, 5: No. 8, 84-91(Aug. 1969). (In Russian).

The effect of fractionated doses of x-rays on the root meristem cells of Crepis capillaris irradiated at the G_1, S, and G_2 interphase stages was studied. The effect of fractionation was observed at a 90 minute interval between the half-doses at the stage G_1 and at a 30 minute interval at the stages G_2 and S. The results obtained are in agreement with Sax's hypothesis assuming a limited lifetime of broken chromosome ends. (auth)

45704 RADIO-SENSITIVITY IN RAGI (ELEUSINE CORACANA). Goud, J. V.; Nayar, K. Muraleedharan; Rao, M. Goalkrishna (Univ. of Agricultural Science, Hebbal, India). Can. J. Genet. Cytol., 11: 254-65(June 1969).

Dry seeds of three varieties of ragi (Eleusine coracana) were subjected to γ irradiation with acute dosage of 20 KR and 30 KR. The mutagenic effects of γ rays in the M_1 generation and the mutation frequency with regard to chlorophyll and viable mutations in the M_2 generation were studied. The LD_{50} appears to be around 30 KR for ragi, although there are enormous varietal differences. Purna is the least and H_{22} the most sensitive to γ irradiation in the M_1 generation. There is a direct correlation between the radiation effect produced as measured by seedling growth, pollen fertility, and seed fertility with the dosage used. Multivalent formation, lagging chromosomes, and stickiness, etc., were observed in meiotic studies in the M_1 generation. The frequency of chlorophyll

mutations was less in populations irradiated with 30 KR than with 20 KR. A wide spectrum and a high frequency of viable mutations were produced in Purna. The mutation frequency (viable + chlorophyll) increased with the dosage. The 200 isolated viable mutations included many agronomic types that are useful either directly or in conventional plant breeding. (auth)

45705 COMPARISON OF MUTAGENIC EFFICIENCY BETWEEN EMS AND γ RAYS. Matsumura, Seiji; Fujii, Taro (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 109-10(1967).

Seeds of a normal strain and heterozygotic F_1 seeds from a cross between normal and chlorina mutant of Triticum monococcum were soaked in water for 2 hr and then treated with 0.1, 0.3, and 0.5% ethyl methane sulfate (EMS) solutions for 22 hr. For comparison, seeds soaked for 24 hr were subjected to 0.5, 1.0, and 1.5 kR of γ rays. Also, EMS and γ-ray treatments were combined to examine the synergistic effect of both treatments. In the normal strain, several types of stripes were observed in many plants during the growth of EMS-treated lots but very seldom in γ-ray lots. About 20% surviving plants had chlorina-like yellowish green stripes in the 0.3% EMS lot, and a similar frequency was also observed in the EMS 0.3% + γ-ray 1.0-kR lot, while such type of stripes was seen in the 3 γ-ray lots. Seeds from some tillers with stripes and from normal green tillers of the same individual were sown and segregation of chlorina seedlings was examined. Albina or other kinds of chlorophyll mutants were segregated among these X_2 seedlings, but no chlorina-like segregants were observed. Thus, no somatic mutations from dominant green to recessive chlorina occurred in F_1 by EMS treatment. In the F_1 strain, numbers of chlorina or chlorina-like stripes in the EMS 0.3% lot amounted to 0.98% and the frequency was almost the same as in the normal strain. Rates of striping in γ-ray lots increased with increase of dose but they were much lower than those of EMS 0.3% lot. The rate in the EMS 0.3% + γ-ray 1.0-kR lot was 1.49% which was higher than the sum from EMS 0.3% and γ-ray 1.0-kR lots. Segregation of several kind of chlorophyll mutants were observed in the X_2 generation of the normal strain. Chlorophyll mutation rate was similar in the EMS 0.1% and γ-ray 1.0-kR lot, but EMS in the 0.3% lot was very high. These results show that the mutagenicity of EMS is very high at high doses when the mutability is compared on the basis of their survival rates. (BBB)

45706 POSTIRRADIATION MODIFICATION AND MECHANISM OF REVERSE DOSE-RATE EFFECT ON MUTATION INDUCTION IN SILKWORM GONIA. Tazima, Yataro; Sado, Toshihiko (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 90(1967).

An enhancing effect on radiation-induced mutation was observed in the silkworm after fractionated exposure of gonial cells. As an interpretation of this phenomenon, some modification in cellular metabolism was assumed to occur. The modified state, which becomes detectable by increased mutation frequency, persists at least for 48 hr and is characterized by a peak appearing 18 to 24 hr after initial exposure. The nondecay type curve suggested that this was not due to a biochemical disturbance but presumably to cell synchronization. When 2 split doses were given to 2 experimental series in reciprocal order (250 R + 750 R and 750 R + 250 R) 6 hr to 48 hr apart, the peak appeared earlier for the initial 250 R than for the initial 750 R series. By labeling S phase cells with ^{3}H-thymidine, it was observed that irradiated cells are blocked in at G_2, favoring the hypothesis of cell synchronization. Cytological observations revealed that the mitotic process of gonia at a rate stage is inhibited, being blocked at G_1 and G_2, during chronic exposure. Furthermore, it was confirmed by a new chronic exposure experiment lasting 3 days, which were started every 24 hr, that the chronic treatment becomes more effective for mutation induction than the acute one as early as one day after hatching, coinciding with the initiation of cellular activity. This observation explains why the dose-rate effect is reversed within a very short period. (BBB)

45707 THE PRODUCTION OF COMMERCIALLY VALUABLE SHOOT VARIANTS IN ROSES BY TREATMENT WITH X RAYS. Streitberg, Hanna (Institut fuer Obstbau, Dresden-Pillnitz, Ger.). Wiss. Z. Humboldt-Univ. Berlin, Math.-Naturwiss. Reihe, 17: 299-302(1968). (In German).

Rose shoots were irradiated with doses of from 500 to 15,000 R of 200-KV x ray. The death rate of the irradiated plants varied linearly with the irradiation dose. The optimal dose, estimated to produce 50% or less deaths, ranged for 3 general types of roses between 1500 to 6000 R, 1000 and 3000 R, and between 500 to 1000 R. Various changes were observed in 14.9% of the plants. The most variants were produced after irradiation with from 1500 to 3500 R, and most appeared as changes in color and form of the blooms, but a few blooms were smaller than normal. Clones were formed from the variants considered to be most useful. (BBB)

45708 EFFECTS OF THE INTERVALS BETWEEN IRRADIATION AND MITOSIS STIMULATION ON THE NUMBER OF CHROMOSOMAL ABERRATIONS IN HUMAN LYMPHOCYTES. de la Vega, R.; Mikhelson, V. M. (National Research Center of Cuba, Havana. Inst. of Cytology, Leningrad). Tsitologiya, 11: 877-80(July 1969). (In Russian).

Human blood plasm with leukocytes was x-irradiated in vitro with doses of 50, 100, and 150 R (14.3 R/min). The lymphocyte cultures in Parker medium were prepared and incubated at 37°C. Phytohemagglutinin (PHA) was added at different times after irradiation: immediately, in 24, or in 48 hrs. The number of chromosome breakages was the same irrespective of the interval between the irradiation and the PHA instillation. Possible reasons for the lack of postradiation recovery are discussed. (auth)

45709 THE INFLUENCE OF PREGANGLIONIC SYMPATHECTOMY ON THE RADIOSENSITIVITY OF CHROMOSOMES IN CORNEAL EPITHELIUM OF MICE. Polyanskaya, G. G. (Leningrad State Univ.). Tsitologiya, 11: 888-91(July 1969). (In Russian).

The influence of the right-side preganglionic sympathectomy on the radiosensitivity of chromosomes in the corneal epithelium was investigated on mice of inbred line CC57-Br. The sympathectomy caused decreased radiosensitivity of the chromosomal apparatus in the corneal epithelium and some tendency to decreasing mitotic activity in the right eye of the irradiated and operated animals in comparison with their left eye. (auth)

45710 EFFECTS OF LASER MICRO-IRRADIATION ON CHROMOSOMES. Berns, M. W.; Rounds, D. E.; Olson, R. S. (Pasadena Foundation for Medical Research, Calif.). Exp. Cell Res., 56: 292-8(Aug. 1969).

Primary cultures of salamander lung cells were vitally stained with varying concentrations of acridine orange and individual chromosomes irradiated with an argon ion laser microbeam. Lesions as small as 0.6 μ were placed on pre-selected sites of chromosomes. The lesions appeared as distinct pieces missing from the chromosome when higher concentrations of dye were applied, or as paled spots on the chromosome when lower concentrations of the dye were applied. The time from irradiation to appearance of the lesion was substantially greater for the low concentrations of dye. All lesions stained negatively for DNA when subjected to the DNA-specific Feulgen reaction. The survival of cells following laser irradiation was optimal for the lower concentrations of acridine orange. Cells were maintained in culture and followed by time lapse movies for five days following irradiation. Lesions were placed on chromosomes at any time during mitosis. Cells continued through division, cytokinesis occurred, and new nuclear membranes and nucleoli were formed. (auth)

45711 INVESTIGATION OF CHROMOSOMAL ABERRATIONS IN PERSONS SUBJECTED TO REPEATED IRRADIATION ASSOCIATED WITH THEIR PROFESSION. Sevan'kaev, A. V.; Bykhovskii, A. V.; Bochkov, N. P. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, 5: No. 7, 126-8(July 1969). (In Russian).

Chromosome aberrations were found in a culture of peripheral blood leukocytes taken from 12 men subjected to repeated professional γ irradiation during periods of time varying from 2 months to 4 yrs. The total cumulative doses received by these men during these periods varied from 0.02 to 2.08 R. The frequency of chromosomal aberrations in this group was shown to be three to four times as high as that in the control group consisting of seven men of the same age. The frequency of aneuploid cells was also higher than in the control group. The determination of the chromosome aberrations in the cultures of peripheral blood leukocytes is recommended as a method of detection of the early symptoms of the organism of low radiation levels associated with the profession of the persons affected and with roentgeno-radiological medical procedures. (auth)

45712 THE EFFECT OF GAMMA RAYS ON HUMAN CHROMOSOMES. IV. THE DYNAMICS OF CHROMOSOME ABERRATIONS IN A LEUCOCYTE CULTURE IN THE COURSE OF SEVERAL MITOSES. Antoshchina, M. M.; Kozlov, V. M.; Bochkov, N. P. (Inst. of Medical Radiology, Obninsk, USSR). Genetika, 5: No. 7, 114-20(July 1969). (In Russian).

The dynamics of the chromosome aberrations in a human leucocyte culture were studied. The cells were irradiated by a 100 R dose of ^{60}Co γ rays before culturing and were harvested after 50, 60, 70, 80, 85, 100, and 120 hrs in culture. The frequency of aberrant cells was observed to decrease during the 70 to 120 hrs period. It was practically the same for the samples harvested after 50 and 60 hrs, when the cells are undergoing the first mitosis. The spontaneous level of chromosome aberrations increased by 120 hrs. After 70 hrs, cultures were a mixture of cells undergoing the first and the second mitosis. There were some cells undergoing the third mitosis after 85 hrs, since some duplicate and qua-

druplicate acentric structures (fragments and rings) were found. The percent elimination was higher for the acentric fragments, than for the dicentrics, although both types of chromosome aberrations were observed in the cultures even after the elapse of 120 hrs. (auth)

45713 A MUTANT OF SALMONELLA TYPHIMURIUM THAT HAS LOST THE CAPACITY OF REPAIRING UV-LESIONS BOTH IN ITS OWN DNA AND IN THAT OF BACTERIAL VIRUSES. Skavronskaya, A. G.; Pokrovskii, V. N.; Zlatev, V. I.; Andreeva, I. V. (Inst. of Epidemiology and Microbiology, Moscow). Genetika, 5: No. 7, 88-92(July 1969). (In Russian).

Several uv-radiosensitive mutants of Salmonella typhimurium were obtained. The mutant P5 had a considerably higher sensitivity to uv rays. Besides the loss of the capacity of repairing its own uv-lesions, this mutant also lost the capacity of repairing the uv-lesions of bacterial viruses, making it a Hcr^--mutant. The mutant P5 was more sensitive to nitrosoguanidine than the Hcr^- mutants of Escherichia coli, being also relatively sensitive to crystal-violet. No characteristics indicative of any disturbances in the function of the ion gene could be observed in the mutant studied. By means of direct crosses it was established, that this mutation was located within the chromosome site situated between the markers ile and try. The mutated gene was not linked to either of these markers. The uv-radiosensitive mutants of S. typhimurium can be used for the analysis of the fine structure of the UVR-genes. (auth)

45714 THE GENE-CONTROLLED RADIATION SENSITIVITY IN THE YEAST SACCHAROMYCES CEREVISIAE. IV. A STUDY ON THE CORRELATION BETWEEN THE GENERAL AND THE GENETIC RESISTANCE IN THE EXPERIMENTS WITH RADIATION-SENSITIVE MUTANTS. Kozhina, T. N. (Ioffe Inst. of Physics and Tech., Leningrad). Genetika, 5: No. 7, 83-7(July 1969). (In Russian).

Two uv-radiosensitive mutants of Saccharomyces cerevisiae were isolated. These mutants exhibited different degrees of increased sensitivity to the lethal effect of uv rays. It was established, that the increase of radiosensitivity was caused by a change in the system of dark repair of DNA lesions. The mutations were localized in two different loci designated as uvs_1 and uvs_2. The frequency of induced serine-resistance mutations was determined in the uv-radiosensitive mutants and in the wild-type haploids. A positive correlation was thus established between the lethal and the mutagenic effects of uv radiation. The data suggest, that the system of postradiation repair described for bacteria is a very important mechanism common to different organisms. This mechanism controls the natural level of radiosensitivity of cells. Its function is the repair of lethal damages and also of lesions potentially leading to other genetic effects. (auth)

45715 INVESTIGATION OF THE GENETIC APPARATUS OF THE SPERM IN MISGURNUS FOSSILIS BY MEANS OF MONOCHROMATIC ULTRAVIOLET RADIATION. Kotomin, A. V.; Dontsova, G. V. (Inst. of Developmental Biology, Moscow). Genetika, 5: No. 7, 33-7(July 1969). (In Russian).

Monochromatic uv irradiation at wavelengths of 254 mμ, 265 mμ and 280 mμ was observed to inactivate entirely the genetic apparatus in the sperm of the loach (Misgurnus fossilis). The embryos developing after the fertilization of the spawn with such sperm, were haploid. The cytochrome oxidase activity is known to increase in the course of the normal development of the loach embryos. After the fertilization of the eggs with the sperm uv-irradiated at a 280 mμ wavelength the increase of the cytochrome oxidase activity was about one half that in the control. The increase of the cytochrome oxidase activity in the haploids after the irradiation of the sperm at a 265 mμ wavelength was entirely suppressed. (auth)

45716 TWO-BREAK (OR LESION) CHROMOSOME ABERRATIONS. Read, John (Wakari Public Hospital, Dunedin, New Zealand). Brit. J. Radiol., 42: 554(July 1969).

The probability of the formation of dicentric plus ring chromosome aberrations in irradiated cells is discussed. The even or odd number of chromosomes present, Brownian movement, culture temperature, and nucleoplasm viscosity were differences discussed that could relate to differences in results. It was concluded that square law dependence on theoretical grounds should not be assumed in the determination of results in studies on chromosome aberration frequency. (C.O.)

45717 RADIOBIOLOGICAL STUDIES OF CEREALS. IV. CHROMOSOME ABERRATIONS AND STERILITY IN THE X_1 GENERATION OF BARLEY TYPES HAVING DIFFERENT RADIATION SENSITIVITY. Walther, F. (Kernforschungsanlage, Juelich, Ger.). Radiat. Bot., 9: 231-40(July 1969). (In German).

Cytological investigations were performed during the first mitosis of the primary root of varieties of summer barley after irradiation of dormant karyopses. The more radiosensitive varieties were found to give a higher rate of chromosomal aberrations. With regard to reduction of the number of dividing cells after irradiation, the varieties tested showed the same behavior, while they differed in the percentages of the various stages of division. In field experiments, with equal x-ray exposures, it was possible to demonstrate that the variety-specific differences in survival rate and fertility of x_1-ears were consistent with the various degrees of radiosensitivity. Differences in radiosensitivity of barley varieties seem to be due mainly to varying degrees of sensitivity for the induction of chromosomal aberrations and mutations. (auth) (UK)

45718 EFFECT OF ULTRAVIOLET LIGHT ON NUCLEAR FUSION IN USTILAGO VIOLACEA. Clements, L. L.; Day, A. W.; Jones, J. K. (Univ. of Reading, Eng.). Nature (London), 223: 961-3(Aug. 30, 1969).

Studies are reported which confirm that uv light increases the frequency of diploid formation and which suggest that fusion of haploid nuclei is induced in approximately 100% of the sporidial pairs of Ustilago violacea after high uv doses. Reduction of the frequency of uv induced diploid formation by a photoreactivation treatment suggests that the site of uv action is in DNA or RNA, as reported for other photoreactivable systems. It may be speculated that the effects of uv light and photoreactivation on dimer production and repair in DNA or RNA molecules also change the nuclear membrane and thus promote nuclear fusion. (UK)

Health Physics and Safety

Refer also to abstracts 45479, 45485, and 46008.

Radioactive Contamination and Decontamination

Refer also to abstracts 45434, 45606, 45628, 45641, 45681, 45682, 45758, and 45943.

45719 (AECL-3290) THE PERSONNEL DECONTAMINATION FACILITY AT WNRE. Weeks, J. L. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Apr. 1969. 7p. Dep. CFSTI (U. S. Sales Only). CAN $0.50.

The factors to be considered in the design of a personnel decontamination area are discussed in relation to previous experience in the atomic energy industry. The design and operation of the recently completed personnel decontamination area at the Whiteshell Nuclear Research Establishment are described. Reference is made to other approaches to the problem of personnel decontamination under conditions involving the presence of radioactive material. (auth)

45720 (AERE-Trans-1105) RADIOACTIVE CONTAMINATION IN WORKSHOPS AND LABORATORIES. VOLUME II. COLLECTIVE PROTECTION TECHNIQES. Perotin, J. P.; Werderer, B. Translated by E. M. Gillis (Atomic Energy Research Establishment, Harwell, Eng.), from report SPR-67-558. 92p. Dep. CFSTI (U. S. Sales Only). UK 13s. 0d.

The subject is reviewed under the following headings: General properties of contaminants (sedimentation, aerosols, gases and vapors, diffusion, coagulation); characteristics of atmospheric contamination (discharge of contaminant, localization in space, localization in time, dispersion of contamination discharged with no initial velocity and aerosols with initial velocity, dispersion by atmospheric convection currents, experimental tests); trapping contamination (effect of an extraction pipe, air extraction using a duct sited away from walls, extraction using a duct placed against a wall, extraction using special shaped nozzle, recommended extraction velocity to ensure good removal, use of an extraction pipe to remove contamination liberated by mechanical action, removal of a contaminant entrained by thermal currents); localization of contamination (principle, laboratory fume cupboards, influence of disturbances in the atmosphere in laboratories, unsealed manipulation cabinets, effect of accidental overpressure, sealed cabinets); entrainment of contamination (homogeneous contamination in space, continuous emission, ventilated areas, short term emission, influence of badly ventilated areas, heterogeneous contamination caused by a localized source, experimental tests); purification of air (trapping by aerosol filters, dynamic characteristics of filters, testing of condition of filters, collection of iodine, parameters of adsorption of iodine on charcoal); discharge into external atmosphere (dilution in plume passing through still air, discharge from chimney at roof level, discharge from a low chimney, calculation of chimney height); contamination of surfaces (physical retention,

forces of retention, forces tending to removal, factors concerning adhesion of particles, practical problems, chemical retention, elimination of contamination, surface protection, preventive measures). (UK)

45721 (ANL–7535, pp 60-5) METABOLIC AND THERAPEUTIC STUDIES OF PLUTONIUM. IV. Lindenbaum, Arthur; Rosenthal, Marcia W.; Lund, Carol J.; Russell, John J.; Smoler, Martin H.; Moretti, Elizabeth S.; Brown, Helen (Argonne National Lab., Ill.).

The effectiveness of glucan as an adjunct to chelation therapy in removal of the polymeric plutonium from the liver that is not amenable to removal by DTPA has been confirmed. A glucan dose of 10 mg/kg was found to be effective. In the presence of DTPA, hepatic plutonium liberated by glucan is excreted via the urine rather than the feces; the usual route of excretion of hepatic plutonium, both with and without DTPA, is through the feces. Immunologic techniques for removal of plutonium deposited in the RES have not proved useful. Administration of polymeric plutonium of narrow particle size range, prepared by a differential precipitation technique, resulted in a higher deposition in RES tissues, and a lower deposition in the skeleton than obtained with previous preparations. This permitted the measurement of the plutonium translocation from the liver to the skeleton. By 100 days, the liver burden in mice had decreased by 20% of the amount injected, and the skeletal burden had increased by 7%. Since these new polymeri plutonium preparations produce a high ratio of marrow plutonium to hard bone plutonium, their use should facilitate the studies of the relation between plutonium localization and bone tumor formation now under way. Electron microscopic autoradiography for determination of the association of plutonium with extra- and intracellular structures in the mouse liver has been demonstrated. (C.O.)

45722 (ANL–7535, pp 65-7) EFFECTIVE DOSE OF DTPA, SPACED AT 3-DAY INTERVALS, IN REMOVAL OF SKELETAL PLUTONIUM. Rosenthal, Marcia W.; Russell, John J.; Moretti, Elizabeth S.; Lindenbaum, Arthur (Argonne National Lab., Ill.).

A prolonged regimen of spaced injections of DTPA is the most effective treatment for removal of plutonium, in any form, after its deposition in bone or liver. Results with mice showed that a dose of 10 mg/kg of DTPA (comparable to the 1 gram dose usually used in man), given at 3-day intervals for only 12 injections, removed an appreciable fraction (one-fifth) of the plutonium deposited in bone; this treatment also hastened the removal of monomeric plutonium from the liver. Optimal DTPA therapy for plutonium poisoning would consist of immediate DTPA administration, to minimize tissue deposits of plutonium, followed by long-term, spaced treatments with relatively low levels of DTPA, to remove the deposits. (auth)

45723 (SWRHL–42-r) ^{131}I DAIRY COW STUDIES USING A DRY AEROSOL (PROJECT ALFALFA). Stanley, Richard E.; Black, Stuart C.; Barth, Delbert S. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). Aug. 1969. 75p. Dep. CFSTI.

This report covers the second controlled release conducted by the Bioenvironmental Research Program to define the mechanisms associated with the transfer of ^{131}I from the environment to cow's milk. Growing alfalfa-oats, hay, and spread green chop were contaminated with a diatomaceous earth aerosol labelled with ^{131}I. Three groups of dairy cows were fed the three types of contaminated forage. One other group of dairy cows was exposed directly to the aerosol for an air uptake study. The smaller particle size of the aerosol used in this study (2 μm) resulted in higher milk-to-forage ratios than were observed in the first study where the particle size was 23 μm. These ratios of peak average milk to peak average forage activities were 0.061 for the hay, 0.036 for the green chop, and 0.032 for the growing alfalfa-oats. (auth)

45724 A SURVEY OF ^{90}Sr AND ^{137}Cs CONCENTRATIONS IN TAIWAN TEA. Chu, T. C.; Cheng, C. H. Hoken Butsuri, 4: 514-17(June 1969).

Samples of Taiwan tea were collected and investigated for ^{90}Sr and ^{137}Cs contents by radiochemical analysis in 1968. The average concentration obtained was 397 pCi/kg or 89.8 pCi/gCa for ^{90}Sr and 116.2 pCi/kg or 7.09 pCi/gCa for ^{137}Cs. The ratio ^{137}Cs/^{90}Sr was found to be 0.29. A comparison with previous reports by different authors is given, and an intercomparison run of ^{90}Sr and ^{137}Cs concentration in diet sample is also included. (NSA of Japan)

45725 RADIONUCLIDE DISTRIBUTION IN PACIFIC SALMON. Jenkins, C. E. (Battelle Memorial Inst., Richland, Wash.). Contract AT(45-1)-1830. Health Phys., 17: 507-12(Sept. 1969).

Seventeen gamma-emitting radionuclides were measured in four different species of Pacific salmon. The concentration of ^{54}Mn and ^{60}Co decreased in the muscle tissue from northwestern Alaska through southern Alaska to the Oregon–Washington Coast, while the concentration of ^{137}Cs decreased less pronouncedly. The distribution pattern of other radionuclides was influenced by the Columbia River, Chinese nuclear testing, and other parameters. Concentrations of natural ^{226}Ra in Alaskan salmon tissue were sufficiently high to permit native fish-eating populations to exceed their maximum permissible ICRP concentrations. Other radionuclides measured were ^{22}Na, ^{40}K, ^{46}Sc, ^{51}Cr, ^{57}Co, ^{59}Fe, ^{65}Zn, ^{88}Y, ^{110m}Ag, ^{140}Ba, ^{152}Eu, ^{203}Hg, and ^{208}Tl. (auth) (UK)

45726 ^{137}Cs CONCENTRATIONS IN NORWEGIAN LYNX AND WOLVERINE. Mohn, Svein Fr.; Teige, Jon (Norwegian Defense Research Establishment, Kjeller, Norway). Nytt Mag. Zool. (Oslo), 16: 50-2(1968).

Measurements of ^{137}Cs concentrations in muscle tissue from the wild predators lynx (Lynx lynx) and wolverine (Gulo gulo) were reported. The biological half-life of ^{137}Cs in lynx and wolverine was ~35 days. The daily diet of 2 kg of reindeer meat may have contained 200 nCi of ^{137}Cs. The values reported for red deer, moose, ptarmigans, and hare have not exceeded about 5 nCi/kg. This indicated that most of the ^{137}Cs in lynx and wolverine was traceable to reindeer. In view of the hunting habits of both lynx and wolverine, it was expected that ^{137}Cs concentrations in both animals would be highest during the late winter and early spring when the consumption of reindeer meat is highest, with a rapid decrease during the late spring and early summer. For wolverine the average ^{137}Cs concentration for 7 males was 58 nCi/kg, compared with 48 nCi/kg for 4 female specimens. It was not possible to relate the levels of ^{137}Cs with the levels in precipitation. (BBB)

45727 THE VARIATION OF ^{90}Sr AND ^{137}Cs IN MILK, SOME FACTORS INFLUENCING THE RADIONUCLIDE CONCENTRATION AND THE EFFECT OF REMEDIAL ACTIONS. Underdal, Bjarne. Oslo, Veterinary College of Norway, 1969. 122p. Thesis.

The three purposes of the investigation were: to chart districts and farms (in Norway) from which milk might have a relatively high ^{137}Cs or ^{90}Sr content; to evaluate factors that might have an influence on their content in milk; and to test the effects of practical remedial action of the content of ^{137}Cs and ^{90}Sr in milk. The highest concentration of ^{90}Sr found was 271 pCi/l. Significant correlations were found for ^{90}Sr in milk with farm land per 1000 l of milk and with annual precipitation. Variations in ^{137}Cs content were greater than that of ^{90}Sr. Significant correlations were found for ^{137}Cs in milk with annual precipitation and with milk yield per cow. Variations from district to district, seasonal effects, stable strontium content, soil pH, farm practices, and feeding practices were studied. Counter measures were discussed on two levels: action at the local farm and action at a central level. Decontamination of milk was also considered. A list of references is provided that stresses bibliographies and symposia proceedings. (C.O.)

Dosimetry and Monitoring

Refer also to abstracts 45417, 45426, 45505, 45510, 45556, 45559, 45594, 45608, 45622, 45797, 45859, 46306, 46654, and 46882.

45728 (AD–690243) IN VIVO MEASUREMENT OF NUCLIDES EMITTING SOFT PENETRATING RADIATIONS. Final Report. Laurer, G. R.; Eisenbud, Merril (New York Univ., N. Y. Medical Center). June 13, 1969. Contract DA-49-193-MD-2962. 48p. CFSTI.

The results of experiments utilizing a 1 mm thick CsI(Tl) crystal in conjunction with a NaI(Tl) crystal anti-coincidence system for the quantitative in vivo assessment of body burdens of low energy photon emitters such as ^{239}Pu, ^{90}Sr, ^{210}Pb, and natural and enriched uranium are reported. Measurements done to obtain optimum crystal thickness have shown a thickness of 1 mm to be a practical compromise for all three nuclides. The use of this thin crystal in conjunction with a NaI(Tl) crystal anti-coincidence system using rise-time discrimination was effective in reducing background in the low energy region by approximately 60%, and the Compton continuum of ^{137}Cs by as much as 70%. The use of this system led to the development of a prototype, portable in vivo counter with an 8 inch diameter by 1 mm thick CsI(Tl) detection crystal and an 8 inch diameter by 2 inch thick NaI(Tl) anti-coincidence crystal. The crystals were mounted in a moveable rig that allows movement in the X, Y, and Z planes. The entire rig, including electronic apparatus—without a multichannel analyzer—weighs on the order of 200 lbs. Calibration measurements performed with the large crystal have shown minimum significant measurable levels of activity (MSA's) that indicate that body burdens, more particularly lung burdens, may be measured at a fraction of the Maximum Permissible Body Burden without the use of a steel room. (TAB)

45729 (ANL-7535, pp 134-7) MONTE CARLO COMPUTATION OF DOSE PARAMETERS IN NEUTRON RADIOBIOLOGY. Frigerio, Norman A. (Argonne National Lab., Ill.).

Monte Carlo computations provide a very useful adjunct to instrumental neutron dosimetry by reason of their ability to explore local dose and LET distributions difficult or impossible to explore experimentally. The present results show the inapplicability of the commonly used average LET distributions and first collision dose (FCD) to problems of neutron radiobiology except as rather crude approximations. In addition, given good experimental values for flux, composition, and geometry, it provides a simple means for correlating observed biological effects with local dose and LET distributions, and for guiding the planning of radiobiological experiments. (auth)

45730 (ANL-7535, pp 137-41) ANGULAR DISTRIBUTION OF SCATTERED, INTERNAL GAMMA RAYS WITHIN A UNIFORM SPHERE. Hubbard, Lincoln B.; Williamson, Frank S. (Argonne National Lab., Ill.).

The gamma-ray doses to a phantom can be divided into an infinite sum of subdoses, the nth subdose being associated with the nth interaction of the gamma rays. For small objects, only the primary and secondary subdoses should be important. For internal sources, the normal Compton scattering is complicated by having an angular distribution to the incident flux. Within a uniform sphere this angular distribution varies from isotropic at the center to more and more backward-peaked as the surface is approached. As the absorption coefficient (μ) increases, this positional-peaking is reduced. The distribution of scattered energy must always be flatter than that of the incident gamma rays; this smoothing effect of scatter is most pronounced at low energies. (auth)

45731 (ANL-7535, pp 141-4) PRIMARY AND SECONDARY DOSES IN UNIFORM SPHERES FROM INTERNAL GAMMA SOURCES. Hubbard, Lincoln B.; Williamson, Frank S. (Argonne National Lab., Ill.).

We have found an upper limit and a lower limit for the average dose from internal emitters in uniform spheres, including both primary and secondary terms. These formulae were developed for spheres only, but the approximation must be good for other reasonably compact bodies, since each higher order term in the dose iteration depends increasingly on the interior points. Neither limiting case used in the two approximations is actually encountered in practice, although at low photon energies (i.e., $E < 0.3$ MeV) most of the Compton scatter is isotropic, and at high photon energies (i.e., $E > 1.5$ MeV) most of the scattered energy is confined to a narrow cone opening in the forward direction. For intermediate energies, the Compton differential cross section for energy can be split into two components. The magnitudes of these components, the forward-scattered component and the isotropic component, can be chosen to preserve the total cross section and the first moment. (auth)

45732 (ANL-7535, pp 144-7) THE ABSORPTION AND SCATTER OF INTERNALLY EMITTED GAMMA RAYS AT 0.66 AND 1.46 MeV. Hubbard, Lincoln B.; Williamson, Frank S. (Argonne National Lab., Ill.).

Approximate absorption functions for 0.662-MeV and 1.46-MeV gamma rays emitted internally have been found. These functions include the effects of proximity to the source and the effects of the surface. They are designed to be incorporated into computer-oriented dosimetry procedures, and to provide an accurate description of the dose without requiring the lengthy computational times needed for a full Monte-Carlo calculation. From the shapes of the fitted approximation function, conclusions can be drawn about earlier techniques, particularly the employment of a simple exponential absorption. First, the edge effects for these sizes are not too great; the maximum effect is only 10% at the surface with $E = 0.662$ MeV. Second, the intermediate region value of the function is of the form of simple exponential absorption; however, it is 9 to 10% above the usual form. Thus, if most of the dose is delivered in the intermediate distance, the dose in the usual exponential absorption case is as much as 10% below the correct value. Using an absorption function of $1.1\ e^{-\mu r}$ should give rather good results, although the inclusion of the edge and near effects by this method will be even more precise. (auth)

45733 (ANL-7535, pp 147-9) THE DISTRIBUTION OF GAMMA-RAY DOSES IN EXTERNALLY IRRADIATED CYLINDERS. Hubbard, Lincoln B.; Williamson, Frank S. (Argonne National Lab., Ill.).

For cylindrical phantoms, bilateral exposure gives a more uniform dose distribution than unilateral exposure. The ratios of minimum-to-maximum point doses are $e^{-\mu R}$ and $e^{-\mu R}$ in the unilateral and bilateral cases, respectively. In addition, the bilateral exposure gives a large region of nearly uniform dose in the central portion of the cylinder. The doses to the dorsal and ventral edges are higher than that to this central region. The mid-line dose underestimates the dose to all other points in the bilateral case. Hence, the midline dose also underestimates the average dose. (auth)

45734 (ANL-7535, pp 153-6) THE RESPONSE OF BEAGLE DOGS TO PROTRACTED EXPOSURE TO ^{60}Co γ RAYS AT 5 TO 35 R/DAY. I. DOSIMETRY. Williamson, Frank S.; Hubbard, Lincoln B.; Jordon, Donn L. (Argonne National Lab., Ill.).

The initial loading of dogs in the intermediate gamma room has been irradiated so that the effect of size of the dogs and the effect of source decay are largely compensated. Further work is in progress to refine the absorbed dose calculation for multilateral exposure, coupled with direct phantom measurements. The absorbed doses given in the preceding section are adequate for preliminary data input, but it is our intention to use the detailed source decay, compensated in 2% steps, and the weekly weight histories of individual dogs to determine the individual doses received by these dogs. (auth)

45735 (IS-2154) SURVEY OF ENVIRONMENTAL RADIOACTIVITY FOR PERIOD JANUARY 1, 1969 TO JUNE 30, 1969. Voss, Milo D. (Ames Lab., Iowa). Aug. 1969. Contract W-7405-eng-82. 20p. Dep. CFSTI.

The environmental monitoring program of the Ames Laboratory of the USAEC for the Ames Laboratory Research Reactor (ALRR) consists of air samples, soil, vegetation, river water, bottom sediment, precipitation, pond water, ALRR outfall, and well water samples. This report covers the period from January 1, 1969 to June 30, 1969. Soil and vegetation samples will be collected later in the year. The ALRR reached full power as of 7/12/65. As of 12/31/68 the ALRR had generated 70,133 megawatt hours of heat. A total of 87,654 megawatt hours of heat was generated as of 6/30/69. The data indicate that the ALRR has not contributed a significant amount of radioactivity to the environment in the Ames area. The conclusion is reached that radioactivity levels recorded for environmental samples represent background conditions from atmospheric fallout and naturally occurring radioactivity. (auth)

45736 (NVO-40(Rev.2), pp 271-99) OFFSITE RADIOLOGICAL SAFETY PROGRAM. Carter, Melvin W. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.).

The radiological safety program of the Southwestern Radiological Health Laboratory (SWRHL) of the U. S. Public Health Service is described. The primary purpose of the program is to document through radiation monitoring and environmental surveillance the offsite radiation exposure from nuclear explosions at the Nevada Test Site. The monitoring program has shown that the small number of underground events that have released radioactivity to the offsite area since the Limited Test Ban Treaty have resulted in radiation doses below the maximum doses for environmental contamination established by the USAEC and the Federal Radiation Council. (C.H.)

45737 (ORNL-tr-2085) DESCRIPTION OF RADIATION FIELDS BY SEPARATION OF PRIMARY AND SCATTERED RADIATION. III. THE TISSUE-AIR RATIO AND THE DEPTH DOSE EVOLUTION AT GAMMA- AND X-RADIATIONS IN THE RANGE OF 0.6 TO 42 MeV. Schoknecht, Guenter. Translated for Oak Ridge National Lab., Tenn., from Strahlentherapie, 136: 24-32 (1968). 15p. Dep. CFSTI.

Based on experimental and published values, a mathematical expression of the tissue-air ratio can be derived for cobalt-60 beams. Moreover, beside the build-up for electron equivalency a build-up for scattered photons can be identified. The equation can be applied without modification for x and gamma radiation between 0.6 and 42 MeV. The necessary parameters for the commonly utilized beams (isotope sources, Van de Graaff and linear accelerators, and betatrons) are given in a table. With this expression on tissue-air ratio, the course of depth dose and percent depth dose can be calculated. For every equation the computer program is outlined, allowing calculation for different geometrical circumstances. The equations are also the basis of calculation with the decrement line systems, for planning of irradiations with static and rotation therapy with high-energy photons. (auth)

45738 PERSONNEL RADIATION MONITORING IN THE RADIODIAGNOSTIC DEPARTMENT. Bushong, Stewart C.; Harle, Thomas S.; Wright, Ann E. (Baylor Coll. of Medicine, Houston, Tex.). Brit. J. Radiol., 42: 632-3(Aug. 1969).

The limitations of personnel monitoring in radiography departments are discussed. The biological significance of dose equivalent measurements obtained with film badges is questioned. Recommendations are made for the inclusion of all pertinent data relating to the position of the film badge on the individual in order to obtain more meaningful dose equivalent measurements. (E.R.B.)

45739 RADIATION EXPOSURE IN DIAGNOSTIC X-RAY DEPARTMENTS. Oliver, R. (Churchill Hospital, Oxford). Brit. J. Radiol., 42: 633(Aug. 1969).

Attention is called to two sources of accidental exposure of staff and patients in diagnostic x ray departments. The first source of such accidental exposures exists where two or more x-ray tubes are operated from one control table. Safety circuits are available for use in this specific case. The second hazard arises from accidental operation of the set under screening conditions. Safety switches of the deadman's handle type or the push-push type are effective in eliminating this hazard. A committee for the investigation of these potential hazards in radiography departments is recommended. (E.R.B.)

45740 A PRACTICAL METHOD OF OBTAINING DENSITY DISTRIBUTION WITHIN PATIENTS. Holt, J. Garrett; Laughlin, John S. (Memorial Hospital for Cancer and Allied Diseases, New York). Radiology, 93: 161-6(July 1969).

A practical method of obtaining densities for treatment planning is described, which utilizes the transmission through the patient of the primary beam of a finely collimated ^{60}Co source. This method is an analytic extension of the Patient Effective Thickness (PET) scan. The relationship between effective density distribution, geometry, and transmission of primary radiation may be put into the form of a matrix equation. The matrix equation may either be solved by Crammer's method or by a computerized matrix inversion program to yield the density distribution within the medium. This method has been applied to patients and has provided valuable data. The mathematical analysis of this method is presented and examples of computations are given. (C.H.)

45741 THE IONIZING RADIATIONS (SEALED SOURCES) REGULATIONS, 1969. Statutory Instruments 1969, No. 808 Factories. London, Her Majesty's Stationery Office, 1969. 20p. 2s.

The regulations are presented under the following headings: Interpretation and general; administration, notifications and records; basic principles of protection; radiological supervision; medical supervision; organization of work; monitoring; radiography and other processes; x-ray crystallography and spectrometry; measurement and detecting devices and static eliminators; schedule of maximum permissible radiation doses. (UK)

45742 RADIATION DOSE FROM NEUTRONS AND PROTONS IN THE ENERGY RANGE FROM 400 MeV TO 2 GeV. Neufeld, Jacob (Oak Ridge National Lab., Tenn.); Snyder, W. S.; Turner, J. E.; Wright, Harvel; Wheatley, B. M.; Wyckoff, Harold O. Health Phys., 17: 449-57(Sept. 1969).

This report was prepared by the Task Group on High Energy Radiation for Committee 3 of the International Commission on Radiological Protection (ICRP). It deals with the calculation of dose and dose equivalent in a tissue phantom irradiated by high energy neutrons and protons. Estimates of the dose due to neutrons and protons in the energy range from 100 MeV to 400 MeV were contained in an earlier report submitted to the Committee. The present work represents an extension of the previous report to the energy range from 400 MeV to 2 GeV. The object of this report is to provide estimates of dose due to high energy neutrons and protons in order to assist in assessing the hazard to personnel encountering high energy radiations in space or near accelerators. Because of the lack of detailed information concerning high energy interactions it has been necessary to make a number of assumptions and simplifications. It is expected that further refinement will be possible as new data become available. (auth) (UK)

45743 CONSIDERATIONS ON THE DISTRIBUTION OF THE EXPOSURE DOSE AROUND PATIENTS "CARRYING" RADIONUCLIDES AND RELATIVE RADIO-PROTECTIVE PROBLEMS. Pompili, G.; Roseo, B.; Spinelli-Ressi, F. (Istituto di Radiologia e Medicina Nucleare, Milan). Radiol. Med., 60: 671-9(July 1969). (In Italian).

The results of a series of exposure dose measurements performed in the space surrounding patients carrying sealed (radium) and unsealed radionuclides (^{198}Au, ^{32}P, ^{131}I) or irradiated with betatrons are reported. The significance for the purposes of protection against the radiations are discussed, and some practical measures are suggested.

45744 DATA ON MILK AND FOOD. Radiol. Health Data Rep., 10: 297-311(July 1969).

The ^{90}Sr, ^{131}I, and ^{137}Cs content of milk samples from Canada, USA, and Central and South America is given for March 1969 and the twelve month period from April 1968 through March 1969, as is the ^{140}Ba content of milk samples from the USA for March 1969. Food surveillance activities are also reported. Data include the radioisotope content of institutional children's diets in the USA during Oct. through Dec. 1968, and the Ca, K, ^{89}Sr, ^{90}Sr, ^{137}Cs, and ^{226}Ra content of total individual institutional diets in the USA for the same period. All data are presented in tabular form. (E.R.B.)

45745 OTHER DATA. Radiol. Health Data Rep., 10: 322-30(July 1969).

The ^{90}Sr content of human bone samples in the United States during April to June 1968 is reported. The Ca content of the ^{90}Sr/Ca ratio are also calculated. Environmental levels of radioactivity in the vicinity of the AEC installations at Canoga, California (Atomics International) and Paducah, Kentucky (Paducah Plant) are given for July to December 1968. All data are presented in tabular form. One underground nuclear test was conducted at the Nevada Test Site by the AEC during June 1969. (E.R.B.)

45746 DATA ON WATER. Radiol. Health Data Rep., 10: 312-15(July 1969).

Data are presented on the gross α- and β radioactivity in raw surface waters of the United States. The data include samplings from selected sites during November and December 1968. All data are presented in tabular form. (E.R.B.)

45747 DATA ON AIR AND DEPOSITION. Radiol. Health Data Rep., 10: 316-21(July 1969).

Surveillance activities of the Radiation Alert Network in the United States, the Canadian Air and Precipitation Monitoring Program, and the Pan American Air Sampling Program are reported for March 1969. The data include the gross β radioactivity in surface air and precipitation in the United States, Canada, and Pan America for the period reported. All data are presented in tabular form. (E.R.B.)

45748 COMPUTER ANALYSIS AND SYNTHESIS OF ^{60}Co ISODOSE CURVES. Moore, Vaughn Clayton. Minneapolis, Univ. of Minnesota, 1968. 164p.

Thesis.

A systematic method has been developed for the transformation of a reference set of isodose curves into any other desired set of isodose curves. The method is based upon the principle of transformation of coordinates. This investigation primarily consisted of the determination of the empirical transformation functions which were needed to produce a reasonably accurate and usable set of isodose curves for a limited set of geometrical conditions. The results of transformations of the reference field to selected other field sizes at the same SSD as well as at two other SSD's were presented; and an analysis of the errors between transformed and original isodose curves were discussed and illustrated. Such transformations produce isodose curves that are within ±2.0 millimeters of the expected isodose curves in most cases. The results of the transformations are well within clinically-accepted accuracy for dosimetric purposes. A computer program, which was developed to perform the analyses and transformations and plot the results, was presented in the form of a program listing. (TSS) (Disser. Abstr.)

45749 COMMENTS ON "QUALITY FACTOR." Neufeld, J. (Oak Ridge National Lab., Tenn.). Health Phys., 17: 625-8(Oct. 1969).

The purpose of this communication is stated to be (a) to indicate that the term "quality factor" has been used to denote different quantities, and to attempt to clarify the confusion; (b) to replace one of the quantities known as "quality factor" by a different concept believed to be more adequate for the purpose of radiation protection. The current interpretation of "quality factor" and confusion in terminology are discussed, including distinctions between $(QF)_{LET}$ and $(QF)_{DE}$ and the relationship between $(QF)_{LET}$ and $(LET)_{\infty}$; the question as to which version of (QF) should retain its original name. It is proposed to introduce a quantity Q representing "quality index," defined as $Q = (DE)_{max}/D_{ph}$, where D_{ph} represents physical dose in an unperturbed field. The distribution of (DE) within a phantom is calculated and $(DE)_{max}$ and other significant quantities that limit the exposure are determined. The steps employed in using the relationship are indicated. (UK)

45750 DISTRIBUTION OF DOSES IN THE SOFT TISSUE IN THE VICINITY OF BONES DURING EXPOSURE TO γ RADIATION FROM ^{60}Co. Lobodziec, Wlodzimierz (Inst. of Oncology, Gliwice, Poland). Nowotwory, 19: 147-52(Apr.-June 1969). (In Polish).

The effects of an angle of γ rays emerging from ^{60}Co on the dose to soft tissue in the vicinity of bones were determined. The measurements were carried out in the phantom made of pressed wood (corresponding to soft tissue) and of aluminum (corresponding to bones). Experiments were carried out using LiF thermoluminescent dosimeters. (auth)

45751 PRACTICAL TIME-DOSE FORMULA FOR X-RAY THERAPY OF SKIN CANCER. von Essen, Carl F. (Christian Medical Coll. Hospital, Vellore, South India. Yale Univ., New Haven). Brit. J. Radiol., 42: 474(June 1969).

A simplified equation was derived from previous data in order to facilitate slide-rule computation of dose-time factors for the single field x-ray treatment of skin epitheliomas. The equation relates skin tolerance to the curative dose as a function of radiation depth dose, area, and overall time based on 5 or 6 treatments a week. The time-dose-area relations expressed by the formula were applied to clinical practice with satisfactory results; clinical judgment of skin tolerance and tumor curability was needed for certain conditions of site, histology, actinic damage, etc. (C.O.)

45752 RADIATION MYELITIS OF THE DORSOLUMBAR SPINAL CORD. Maier, John G.; Perry, Ronald H.; Saylor, William; Sulak, Michael H. (Walter Reed General Hospital, Washington, D. C.). Radiology, 93: 153-60(July 1969).

Radiation myelitis of the thoracolumbar spinal cord developed in 15 among 343 patients surviving a minimum period of three years following radiation therapy for malignant germ-cell tumors of the testis. The time-dose relationships have been reviewed and the relative risk of development of such sequelae evaluated. In planning radiotherapy where the thoracolumbar spinal cord must be included, consideration must be given to the length or volume of spinal cord irradiated, the dose per fraction, the number of fractions, and the interval between fractions as well as the total dose and overall time. The nominal single dose (NSD) concept of Ellis appears useful in correlating several of these factors and planning appropriate therapy. An NSD of 1,300 RET (rad equivalent therapeutic) is recommended as a tolerance level for large-volume irradiation to the thoracolumbar spinal cord, utilizing ^{60}Co radiation or its equivalent. A midplane tissue dose of 4,000 rad to the thoracolumbar region administered in 20 fractions over a twenty-eight day total treatment time with ^{60}Co in an adult patient of average dimensions approximates the recommended tolerance level of 1,300 RET to the spinal cord in this area. (auth)

45753 CALCULATIONS OF THE ABSORBED DOSE IN A PHANTOM FROM PHOTON FLUENCE AND SOME APPLICATIONS TO RADIOLOGICAL PROTECTION. Sidwell, J. M. (The Polytechnic, London); Burlin, T. E.; Wheatley, B. M. Brit. J. Radiol., 42: 522-9(July 1969).

The dose distributions in a phantom man exposed to monodirectional electromagnetic radiation in the energy range 0.02 to 1.25 MeV were calculated as a function of incident fluence. This procedure was consistent with established practice in neutron dosimetry. The calculations were performed by a Monte Carlo technique whereby 30,000 photon histories were followed down to a cut-off energy of 10 keV. The results were used to derive the integral over the mass of both dose and dose squared. Doses to the gonads and other organs in several radiation fields were calculated and compared with experimental data. The critical organ was thus identified and the possibility of designing a risk meter based on these data is noted. (auth)

45754 TISSUE COMPENSATION WITH LEAD FOR ^{60}Co THERAPY. Wilks, R.; Casebow, M. P. (St. Bartholomew's Hospital, London). Brit. J. Radiol., 42: 452-6(June 1969).

Compensation for the effect of missing tissue, using lead filters, was investigated experimentally on a ^{60}Co unit. Curves of lead filter thickness required to compensate for various tissue deficits at different depths were obtained, and from these, estimates were made of the errors in tumor dose when compensating at a depth other than the tumor depth. As a means of minimizing these errors, two depths (5 and 10 cm) were deduced as being representative of shallow and deep tumors, and the variation of filter thickness with field size was investigated at these depths. The errors produced by changes in both SSD and in the use of equivalent squares for rectangular fields were also estimated and found to be negligible within the ranges examined. A semi-empirical method, using central axis depth dose data, was also developed and the resulting compensation curves compared with those obtained experimentally. The effectiveness of compensation was then checked experimentally for a typical surface shape. (auth)

45755 WHOLE-BODY COUNTING AND BIOASSAY DETERMINATIONS MADE ON ACCELERATOR WORKERS. Patterson, H. W.; de Low-Beer, A.; Sargent, T. W. (Univ. of California, Berkeley). Health Phys., 17: 621-5(Oct. 1969).

A bioassay program is described involving urinalysis and whole body counting on 93 accelerator workers. Details are given of the characteristics of the accelerators involved, the isotopes to be expected from irradiation or relevant materials, the techniques adopted, and the results obtained. The workers studied showed the following incidence of radioactive contamination: α 4%, γ 6%, β 94%. It is believed that the high incidence of β-activity represents environmental contamination. The activity levels did not exceed 1 pCi per 24 hr urine sample for α-emitters, and 10 nCi per whole body count for γ-activity. No changes in health physics procedures were deemed necessary, although the value of such special surveys is emphasized. (UK)

45756 ^{239}Pu IN HUMAN TISSUES AND BONE. Magno, Paul J. (Bureau of Radiological Health, Winchester, Mass.); Kauffman, Peter E.; Groulx, Paul R. Radiol. Health Data Rep., 10: 47-50(Feb. 1969).

An average concentration of 7×10^{-11} μCi ^{239}Pu/g was found in human bone samples ranging in age from 2 to 24 years. This concentration results in an average dose equivalent rate to bone of about 0.3×10^{-4} Rem/year. An average concentration of 7×10^{-10} μCi ^{239}Pu/g found in liver samples from older adults results in an average dose equivalent rate of about 7×10^{-4} Rem/year. These figures were compared to the Federal Radiation Council's Radiation Protection Guides and the dose limits recommended by the National Council on Radiation Protection and Measurements and the International Commission on Radiological Protection. From the data in this report, it was concluded that the concentrations of ^{239}Pu in body tissue result in average equivalent dose rates well below the suggested radiation protection guides and dose limits. (auth)

45757 CALCULATION OF PERCENTAGE DEPTH DOSE IN REGIONS OF BUILD-UP. Bomford, C. K. (Hammersmith Hospital, London). Brit. J. Radiol., 42: 551-2(July 1969).

An equation for valid correction of radiation dose distribution for radiation energies in the range of 2 MV and 31 MV and focus-skin distances of 75 to 100 cm is presented; the build-up region of the beam of radiation is not ignored. The formula can be readily used by a computer for all points at less than the peak depth and any correction can be applied. (C.O.)

45758 COLLOQUE INTERNATIONAL SUR LA DOSIMETRIE DES IRRADIATIONS DUES A DES SOURCES EXTERNES, PARIS, 23–27 NOVEMBRE 1964. TOME II. (International Conference on Dosimetry of Irradiations from External Sources, Paris, November 27–27, 1964. Volume II). Le Vesinet, France, Service Central de Protection Contre Les Rayonnements Ionisants, 1967. 186p. (In French and English). (CONF-803-(Vol.2)).

Twenty five papers are presented in Volume 2 of the proceedings of the 1964 symposium on the dosimetry of external sources. The papers are divided into five categories; the dosimetry of thermal, intermediate, and fast neutrons, special problems in the field of dosimetry in relation to activation studies and personnel dosimetry, statistical studies of dosimetry under extenuating circumstances, dosimetry in routine or special surveillance activities, and dosimetry under conditions of reactor surveillance. (E.R.B.)

45759 COLLOQUE INTERNATIONAL SUR LA DOSIMETRIE DES IRRADIATIONS DUES A DES SOURCES EXTERNES, PARIS, 23–27 NOVEMBRE 1964. TOME I. (International Conference on Dosimetry of Irradiations from External Sources, Paris, November 23–27, 1964. Volume I). Le Vesinet, France, Service Central de Protection Contre Les Rayonnements Ionisants, 1967. 169p. (In French and English). (CONF-803-(Vol.1)).

Twenty four papers are presented in Volume 1 of the proceedings of the 1964 symposium on dosimetry of external sources. The papers are divided into four categories; theoretical problems on the measurement of radiation dose including methods and objectives, theoretical problems relating to shielding and energy distribution, problems of dosimeter calibration, and development, use, and precision of photo- and thermoluminescent dosimeters. (E.R.B.)

45760 CALCULATION OF THE BURDEN AND DOSE TO THE RESPIRATORY TRACT FROM CONTINUOUS INHALATION OF A RADIOACTIVE AEROSOL. Kotrappa, P. (Univ. of Rochester, N. Y.). Health Phys., 17: 429-32(Sept. 1969). (UR-49-964).

The recently proposed ICRP Lung Model can be used to calculate the burden and dose to the respiratory tract from the inhalation of a known radioactive aerosol. Snyder has given analytical expressions and curves to compute such quantities for a single intake. This paper gives expressions and curves for the case of continuous intake. The use of these curves is illustrated by an example in which burdens and doses to various compartments of the respiratory tract are computed for the chronic inhalation of plutonium oxide aerosol making use of the aerosol data available from Hanford Laboratories. (auth) (UK)

Radiation Protection

Refer also to abstracts 45665 and 45826.

45761 (EGG-1183-2177) OPERATIONAL HEALTH PHYSICS: IN-HOUSE OR COMMERCIAL SERVICES. Technical Paper Number S-51-TP. Handloser, J. E. (EG and G, Inc., Goleta, Calif.). Mar. 1969. 7p. (CONF-690102-17). Dep. CFSTI.

From Health Physics Society Midyear Topical Symposium, Los Angeles, Calif.

Industrial uses of radiation require a large expense for health physics programs. It is suggested that the use of commercially available health physics services would be more economical, especially for small industrial users. (C.H.)

45762 PERFORMANCE OF TWO TYPES OF GAS MASK CARTRIDGES FOR REMOVAL OF AIRBORNE RADIOIODINE. Naritomi, Mitsuo (Japan Atomic Energy Research Inst., Tokai); Fukuda, Seiji. Hoken Butsuri, 4: 502-8(June 1969). (In Japanese).

Two types of cartridges to be attached to full face gas masks, which are commercially available and have been in use for the purpose of preventing inhalation hazard due to airborne radioactive materials for a few years at JAERI, were examined for the performance of removing airborne radioiodine in order to obtain data necessary for establishing a measure of the radiation protection in wearing them. The airborne radioiodine-131 discharged into the exhaust system during the processing of iodine-131 at the radioisotope production plant was used for the tests, the concentrations of which ranged from 10^{-5} μCi/cc to 10^{-8} μCi/cc. The tests were carried out at the flow rate of 20 l/min (moderate work) and 40 l/min (medium hard work), respectively, under conditions of relative humidities being in the range of 50% to 70%. The experimental results on the penetration of airborne radioiodine in two types of cartridges as a function of the period of air flow and the relationship between the concentration and the service time, considering the leakage at the seal between the mask and face are discussed. (NSA of Japan)

45763 LECTURE ON PERMISSIBLE DOSES FOR INTERNAL RADIATION. Gaspar, Emilian. Inform. Doc. Selec., Teh. Nucl., 12: 30-44(Jan. 1969). (In Rumanian).

A brief review is presented of basic safety standards for radiation protection, permissible doses for internal radiation, and tabulated data on toxicity classifications of radionuclides. (R.V.J.)

45764 TRENDS IN RADIATION PROTECTION. Richards, Albert G. (Univ. of Michigan, Ann Arbor). J. Mich. State Dent. Ass., 51: 18-21(Jan. 1969).

Progress in dental radiology that has afforded protection against excessive exposure is reviewed against a background of increased knowledge of radiation hazards. Speed of x-ray film has allowed a 96% reduction in radiation dose received by the patient. The U. S. Public Health Service program designed to aid the dentist in modifying his x-ray machine to meet certain standards of filtration and collimation has assured a reduction in the exposure of both the patient and dentist. Knowledge of the biological effects of ionizing radiation in man has expanded widely during the past decade. Studies of the radiation-induced mutation frequency from x rays in mouse spermatogonia measured at exposure rates ranging from 90 to 0.001 R/min have shown a minimum mutation frequency at 0.8 R/min. This frequency was between $\frac{1}{3}$ and $\frac{1}{4}$ of that occurring at 90 R/min. Raising the exposure rate above 90 R/min gives no noticeable increase in mutation frequency in the spermatogonia of the mouse. Unlike spermatogonia, the oocytes exhibit a continuing reduction in mutation frequency to a very low value at the minimum exposure rate tested. There is now evidence that the exposure rate effect is due to repair of mutational or premutational damage. The interval between irradiation and conception in the male mouse apparently has no significant effect on the frequency of mutation. However, this interval has a tremendous effect on the mutation frequency in the female mouse. Small exposures of high dose rate irradiation gave fewer mutations than expected on the basis of a linear relation with the mutation frequency from large exposures at the same high exposure rate. Thus, the significant genetic effects of ionizing radiation in man are probably not linearly related to exposure, irrespective of exposure rate. These results indicate that we have erred on the conservative side, and a much larger margin of safety exists than had been previously known. (BBB)

45765 CHANGE IN RADIOGRAPHIC PRACTICE SHOWS PROGRESS IN RADIATION CONTROL. Scavotto, S. P. (Massachusetts Dental Society, Boston); Dempsey, E. P.; Flynn, E. W.; Maitland, A.; Wellock, W. D. Mass. Dent. Soc. J., 18: 24-6 (Winter 1969).

The extent to which dentists were employing recommended radioprotective practices in 1958, 1963, and 1968 is compared. There has been a substantial increase in the use of x-ray machines operated at higher kilovoltage (>70 kV). This change took place mostly in the first 5-yr span of observation. As the cooperative program progressed, it was evident that other basic recommendations were followed. Thus, proper filtration and collimation were added to the x-ray tube head. Dentists largely have a preference at this time for 2 film-speed groups. The preference for these films has reduced the average exposure time from that of 5 and 10 yr ago. However, the continued preference for film of speed B by a substantial number of dentists limits the reduction in exposure times that is possible. Dentists are improving their techniques as seen by the 65% drop since 1958 in milliampere-minutes per week per x-ray unit. Secondly, they are installing more x-ray units to meet an increase in workload. In the past 5 yr dental offices reported a 20% increase in film use but, during the same period, a slight decrease of x ray "on time" (as milliampere-minutes) to accomplish this increased workload. The range of R dose per film as found in these surveys decreased considerably. The upper limits of exposure have been reduced by a factor of 80% during the past 10 yr. These upper limits of exposure can be reduced further by the dentist if he would use faster film and institute a more precise film processing technique. (BBB)

45766 STOP STRAY RADIATION. Meistroff, C. L. Tic (Albany, N. Y.), 26: 1-2(Apr. 1967).

A simple method is presented to allow dentists to stop stray radiation at the equipment source. No detailed fabrication, modification, or alteration of the circuitry or x-ray machine is required. The pointed plastic cone is the primary source of unwanted and unnecessary stray radiation in dental radiology. A 12- to 14-in.-long Cu tube is fitted to the outside of the cone sleeve and attached to it by several self-tapping screws. The tubing should fit snugly on the outside of the cone up to the point where the base fits into the tube head container. It is not necessary to cut off the cone-pointed section. The tubing should be long enough so that there will be about 14 to 16 in. in length from the tube head center to the end of the new metal tube itself. This distance is measured from the yoke that holds the tube head and permits its swinging and positioning. The added weight of the new metal tube should not upset the balance of the tube head or container. It may be necessary to cut an inch or so from the initial length to arrive at the proper balancing length, but a final 12- to 14-in. focal distance should be obtained. (BBB)

45767 SOME ASPECTS OF RADIATION PROTECTION IN A DIAGNOSTIC DEPARTMENT, EMPHASIZING ELECTIVE EXAMINATION OF FEMALES OF REPRODUCTIVE AGE. Bennett, Robert (Preston and Northcote Community Hospital, Preston, Australia). Australas. Radiol., 13: 224-9(May 1969).

Implementation is described of the recommendations of the 57th Session of the National Health and Medical Research Council of Australia in the radiodiagnostic department of a 312-bed hospital. Nomographic calculations of the approximate skin dose are recorded for each examination performed. A master card is maintained for each patient, containing his radiological records. Requests for examinations of the hips of children and any obstetrical radiological examination must be referred to the radiologist. In cases of pregnancy examinations, the radiologist usually examines the patient clinically and attempts to locate the foetal position. He then assists in positioning the patients, localizing the points for centering and determining the exposure to be given. In case of unknown pregnancy, radiological examination of the lower abdomen and pelvis is confined to 10-day interval following the onset of menstruation. In the operating theatre, a film badge is worn by the surgeon during operative cholangiography and other theatre x-ray examinations where he must remain present. The provision of polythene connectors make it possible to carry out injection of contrast media, while standing behind a mobile lead drape, covered with a sterile drape. (Australia)

45768 EYE PROTECTIVE PANEL FOR FLASH-BLINDNESS PROTECTION USING TRIPLET STATE PHOTOCHROMISM. Dawson, William R.; Windsor, Maurice (TRW Systems, Redondo Beach, Calif.). Appl. Opt., 8: 1045-50(May 1969).

A photochromic panel is described that has a viewing area of 15.0 cm × 20.0 cm and a thickness of 6.0 cm. It includes two photochromic plates of epoxy plastic containing four aromatic hydrocarbon compounds that are excited to their triplet states with two xenon flashlamps. The triplet absorption of the aromatic compounds results in a photochromic absorbance of 2.42 when the panel is activated with a 3000-J flash; 85% of the final absorbance is achieved 150 μsec after the beginning of the flash. The transmission of the panel recovers to 37% 5 sec after the panel darkens. The open-state transmission of the panel is 83%. (auth)

45769 RADIATION: FACTS VERSUS FEARS. Phillips, James E. (Univ. of Pennsylvania, Philadelphia). Pa. Dent. J., 33: 263-8(Oct. 1966).

Dental x-ray practices which contribute to excessive exposure of patients are reviewed and recommendations are made for reducing such exposure, with remarks on Pennsylvania state requirements for dental radiation control. The gonadal exposure from the full mouth examination (0.0025 R) represents the equivalent of 10 days of natural background exposure. This is the value with the use of a medium speed film. If the same examination is performed with a fast film, the face will be exposed to about 5 R and the go-

nadal exposure will be about 0.0005%, or equivalent to about 2 days of natural background exposure. A fast film requires only 20% of the exposure required by a medium speed film. Changing from a medium speed film to a fast film reduces the exposure of patient more than any other means available to the dentist. The fast films give roentgenograms which are of high quality, and it is generally not possible to distinguish them from roentgenograms made with medium speed film. Added filtration is regulated by law in most states. Pennsylvania requires total filtration equivalent to 2.5 mm of aluminum. Proper chemical development of x-ray films is an important method of reducing the radiation exposure of the patient. Developing time should never be less than that recommended by the manufacturer. If a shorter time is recommended, it is sometimes possible to decrease the exposure time and increase the developing time to 5 minutes. If a short developing time is used, the film must be overexposed to achieve satisfactory film density. Such overexposure represents inefficiency in the use of radiation. (BBB)

Safety Procedures

Refer also to abstracts 45427–45429, 45431, 45739, and 45940.

45770 (CEA-CONF-1315) URANIUM TOXICITY WITH SPECIFIC REFERENCE TO ITS RADIATION HAZARDS. Jammet, H.; Mechali, D.; Dousset, M. ([Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires]). [nd]. 10p. (CONF-690425-2). Dep. CFSTI (U. S. Sales Only).

From International Conference on Pneumoconiosis, Johannesburg, South Africa.

In relation to studies of the deposition and retention of aerosols, the mechanisms that occur in the clearance of the respiratory tract compartments are schematically portrayed as well as the fate of the cleared materials. The toxicity of these materials depends on their metabolism after passing into the systemic blood, on the sensitivity of the tissues where the toxic is deposited, and above all on the relative importance and the kinetics of the different respiratory tract clearance mechanisms. The fate of uranium compounds introduced into the systemic blood following inhalation is reviewed. Its toxicity to the organism depends upon whether the compound is highly diffusible or hardly diffusible. Based on these diffusibility characteristics, maximum permissible concentrations of natural uranium compounds in the working environment were determined: for diffusible compounds–210 $\mu g/cm^3$, and for hardly diffusible compounds–150 $\mu g/cm^3$. In determining the toxicity of uranium daughters in mine atmosphere, two considerations must be taken into account; on the one hand radon and its short-lived daughters must be considered, and on the other hand the dusts containing uranium long-lived daughters. These factors raise difficulties in selecting models for dose calculations. The radionuclides and their activities among the radon daughters and the remaining long-lived uranium ore dust residues are discussed. The relation between radon and lung cancer among uranium miners is reviewed and specific studies are recommended. (E.R.B.)

45771 (EUR-4248) PRACTICAL VALUE OF HEMOGRAMS IN OCCUPATIONAL MEDICINE IN A NUCLEAR RESEARCH CENTER. Tanguy, H.; Antonini, G.; Federico, A.; Zocchi, E. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1969. 16p. (In French). Dep. CFSTI (U. S. Sales Only).

On the basis of 9605 hematological controls carried out on 942 workers of the Euratom Research Center at Ispra (Italy), a blood formula is given which can be considered normal in the European Community countries according to nationality, sex and age. The monthly variations of this formula and the percentage of its inversion—over 50% increase in the mononuclear rate—are discussed. The influence of the exposure—both internal and external—to ionizing radiations appears to be ineffective. In conclusion, in view of the large variations in the formula both among different individuals and within the same subject at different times, the meaning of the complete determination of the blood formula in the field of occupational medicine is called in question. (auth)

45772 (GAT-R-517) HEALTH AND SAFETY ACTIVITIES REPORT FOR 1968. (Goodyear Atomic Corp., Piketon, Ohio). Aug. 29, 1969. Contract AT(33-2)-1. 51p. Dep. CFSTI.

The health and safety activities at Goodyear Atomic Corporation are divided between two major specialized groups—the Medical Subdivision and the Safety Department. Some of the activities of these groups are peculiar to atomic energy gaseous diffusion operations; other activities are typical of those found in most large industrial organizations. This report covers the significant activities of the various groups and their resultant statistics compiled during 1968. Functions performed by both health and safety groups include: medical examinations, fitting and repairing safety glasses, urinalyses, first aid and medical care, noise level surveys, equipment inspections, accident investigations, radiation control, and environmental testing. Many of these services are performed on a routine basis, while others are scheduled as needed. The Goodyear program appears to be serving the best interests of Goodyear personnel, the neighboring communities, and the Atomic Energy Commission. (E.R.B.)

45773 ASSESSING THE PROBABLE SEVERITY OF PLUTONIUM INHALATION GASES. Heid, K. R.; Jech, J. J. (Battelle Memorial Inst., Richland, Wash.). Health Phys., 17: 433-47(Sept. 1969).

An early assessment of the magnitude of the probable internal deposition expected from a plutonium incident is essential to expedite a proper course of action. Prompt decisions are necessary to maximize the effectiveness of any subsequent therapeutic treatment. For installations that do not have readily available in-vivo counting capabilities, these vital decisions must be based upon available survey data, which are often extremely limited and difficult to interpret. Guides which are useful in making prompt interpretation of these data have long been needed. In an effort to establish such guides, various data associated with plutonium inhalation incidents were collected over a period of several years. This paper summarizes the types of data being collected and the criteria used for collection, and correlates the survey data to evaluations of internal depositions based on bioassay data. Additional capabilities for making early evaluations are offered by recent advances in lung counting techniques and by the concepts presented in the new ICRP Lung Model. Comparisons of evaluations utilizing these various techniques are described for a few actual plutonium inhalation cases. (auth) (UK)

Legal Aspects

45774 RADIATION QUANTITIES AND UNITS. ICRU REPORT 11. Washington, D. C., International Commission on Radiation Units and Measurements, 1968. 16p. $1.00. GPO $1.00.

The International Commission on Radiation Units and Measurements (ICRU), since its inception in 1925, has had as its principal objective the development of internationally acceptable recommendations regarding: quantities and units of radiation and radioactivity; procedures suitable for the measurement and application of these quantities in clinical radiology and radiobiology; and physical data needed in the application of these procedures, the use of which tends to assure uniformity in reporting. The International System of Units (SI) has been adopted. Limited modifications and corrections are reported that were approved by the Commission at its 1967 meeting. (C.H.)

45775 RADIATION PROTECTION LAW MANDATORY. Flynn, Charles R. (Maryland State Health Dept., Baltimore). J. Md. State Dent. Ass., 12: 10-11(Apr. 1969).

The present status of dental radiation protection in Maryland is discussed. The program of radiation protection of the Maryland State Health Department emphasizes the requirement of dentists to register all x-ray units and to submit a plan review of new dental installations. Although there are 1744 dental x-ray units registered in Maryland, the Department is still finding unregistered units. Regulations governing radiation protection which became effective on January 1, 1964 require that all new installations be registered within 30 days. Of the 3608 x-ray units registered in Maryland, 2917 have been surveyed. The most frequent items of nonconformance found during a physical survey are improper collimation, filtration, and operator position. During the survey, exposure rates are measured in various areas to determine the safest operator position. The Maryland State Dental Association code on radiation hygiene is outlined. (BBB)

45776 GOVERNMENT AGENCIES: WHAT'S BEING DONE IN MEDICAL RADIATION. Your Radiol. (Chicago), 10: 7-16 (Fall 1967).

Federal agencies and programs in the field of radioprotection are reviewed. The U. S. Public Health Service has no regulatory authority in radiological health, but one of its agencies is more directly concerned with medical radiation than any other federal group. Its National Center for Radiological Health in Rockville, Maryland, has carried out an increasingly broadened program that covers the entire spectrum of government participation. A basic activity of NCRH is a continuing project, the Environmental Radiation Surveillance Program, which measures the radiological levels of the environment in all 50 states. The 5 divisions in the program are outlined. Air surveillance is conducted at 74 stations that monitor fallout in the atmosphere. Pasteurized milk is examined at 60 stations to determine the amount of radioactivity

present. Institutional diet samples are taken at 29 boarding schools and orphanages throughout the United States each week to measure radioactivity in the food being consumed by the population under 18 yr. Human bone sampling is done by 140 pathologists and medical examiners who submit samples regularly to check on the presence of ^{90}Sr. The bovine thyroid network includes 20 slaughterhouses in 16 states which deliver regular samples for testing. The function of the Atomic Energy Commission Division of Biology and Medicine and the Health Protection Branch of the Division of Operational Safety in medical radiation studies are also outlined. A chart is provided showing the structure and chain of command of these and other federal agencies engaged in medical radiation protection. (BBB)

Medicine

Refer also to abstracts 45359, 45479, 45481, 45504, 45574, 45776, and 45859.

45777 (TT-68-50006/5) POLISH MEDICAL JOURNAL, VOL. 7, NO. 5, 1968. Translated for National Library of Medicine, Washington, D. C., from selected Polish medical publications. 259p. CFSTI.

A separate abstract was prepared for four articles. (C.H.)

For abstracts of individual papers see: 45816, 45913, 45914, and 45937.

45778 (TT-68-50006/6) POLISH MEDICAL JOURNAL, VOL. 7, NO. 6, 1968. Translated for National Library of Medicine, Washington, D. C., from selected Polish medical publications. 266p. CFSTI.

Abstracts of two papers in the translated Polish Medical Journal No. 6, 1968, were prepared for inclusion in NSA. A total of 22 other papers were published in this issue, with an emphasis on biochemical studies of medical problems. (C.O.)

For abstracts of individual papers see: 45661 and 45791.

45779 CLINICAL RADIOBIOLOGY: THE ROLE OF OXYGEN CONCENTRATION. pp 29-38 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of eight papers are presented. Radiosensitivity of tumors is studied under various conditions of oxygen tension produced either in high pressure chambers or by ozone or hydrogen peroxide. (H.G.G.)

45780 AUTOMATIC EVALUATION OF DATA FOR THE FUTURE OF RADIOLOGY. pp 7-16 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of ten papers are presented. The role of computers for evaluation of x ray films and nuclear medicine data is discussed. Program directed dosimetry, comparison of code systems, and mathematical evaluation of scintigrams are analyzed. (H.B.G.)

45781 DEUTSCHER ROENTGENKONGRESS 1968. REFERATE UEBER DIE 49. TAGUNG DER DEUTSCHEN ROENTGEN-GESELLSCHAFT, VOM 6. BIS 9. JUNI 1968 IN HAMBURG. (German Roentgen Congress 1968. References on the 49th Meeting of the German Roentgen Society, June 6-9, 1968, in Hamburg). Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. 246p. (CONF-680656).

Separate abstracts were prepared for eighteen sections of the conference for inclusion in NSA. Two sections of the conference dealing with roentgenological morphology of face and neck in malignant diseases, and angiography of the abdomen in malignant diseases, respectively, are not included. (H.B.G.)

For abstracts of individual sections see: 45779, 45780, 45802-45809, and 45837-45844.

Protective Substances

Refer also to abstracts 45651, 45674, 45679, 45861, 45862, 45880, 45948, and 45968-45971.

45782 (AEC-tr-7088) METABOLISM AND TOXICITY OF THERAPEUTIC CHELATING AGENTS. REPORT NO. 2. EFFECT OF DTPA ON THE ENTERAL RESORPTION OF ZINC. Bohne, Felicitas; Nigrovic, Vladimir; Harmuth-Hoene, Anna-Elisabeth. Translated by A. A. Horvath for Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex., from Strahlentherapie, 134: 293-5(1967). 3p. Dep. CFSTI.

The relative absorption of Zn from the intestine of the rat decreases with increasing Zn-dosage. Simultaneous parenteral administration of DTPA does not enhance the absorption of Zn but leads solely to an elevated urinary excretion of the absorbed fraction. Pretreatment with DTPA is followed by an enhanced retention of Zn. (auth)

45783 (AEC-tr-7091) METABOLISM AND TOXICITY OF THERAPEUTIC CHELATING AGENTS. REPORT NO. 3. EFFECT OF EDTA AND DTPA ON THE ELIMINATION OF ENDOGENOUS ZINC. Havlicek, Frantisek. Translated by A. A. Horvath for Lovelace Foundation for Medical Education and Research, Albuquerque, N. Mex., from Strahlentherapie, 134: 296-305(1967). 14p. Dep. CFSTI.

Experiments with rats show that the Ca-chelates of DTPA and EDTA give rise to a transient Zn-depletion of the organism. Zn is mobilized from the extracellular space and partially from the intracellular space, mainly from the liver. The mobilized fraction is excreted with the urine whereas the fecal elimination is lowered. DTPA proved to be 100 times more effective than EDTA. (auth)

45784 (ANL-7535, pp 95) POSSIBLE RELATIONSHIP IN THE MOUSE BETWEEN WHOLE-BODY CATALASE AND SENSITIVITY TO X RADIATION. Feinstein, Robert N.; Faulhaber, Joann T.; Howard, Judith B. (Argonne National Lab., Ill.).

Whole body catalase levels and LD_{50} to acute whole-body x radiation were determined on two sets of mice: hypocatalasemic, homozygotes and acatalasemic heterozygotes. The results further strengthen the tentative conclusion that low blood and solid tissue catalase content is protective, rather than deleterious, to an irradiated animal. (C.O.)

45785 (ANL-7535, pp 98-9) SENSITIVITY OF ACATALASEMIC MICE TO RADIATION-INDUCED MOTIVATION. Morris, Dale D.; Feinstein, Robert N. (Argonne National Lab., Ill.).

Twenty acatalasemic and 20 normal mice were tested for saccharin preference, x irradiated at 200 R, and then retested. Results showed no preirradiation difference between the two groups. Both strains of mice showed significant saccharin aversion after conditioning with saccharin and after x irradiation (unconditioned stimulus). Acatalasemic mice had significantly less aversion than normal mice. Since there is no evidence for any difference between these two groups of mice, other than the level of catalase in their tissues, it is possible that it is not the catalatic activity of the catalase that is responsible but, rather, its peroxidatic activity, producing a compound which is, at present, unknown. (C.O.)

45786 SYNTHESIS OF POTENTIAL ANTIRADIATION AGENTS FROM 3-SUBSTITUTED 2-OXAZOLIDINONES DERIVED FROM PHENOL, BENZENETHIOL, AND RELATED COMPOUNDS. Elliott, Robert D.; Johnston, Thomas P. (Southern Research Inst., Birmingham, Ala.). J. Med. Chem., 12: 353-7(Mar. 1969).

The HBr cleavage of 3-substituted 2-oxazolidinones was effectively applied in the synthesis of N-substituted and N,S-disubstituted derivatives of 2-aminoethanethiol in which the N substituent is a 2-phenoxy-, (phenylthio)-, (phenylsulfonyl)-, or (2-pyridylthio) ethyl or a correspondingly 3-substituted propyl group. None of these modifications of the amino group led to radioprotective activity approaching that of the parent compounds. The products were tested in lethally irradiated mice ($LD_{100/30}$ doses of 1000 R of γ rays and 825 R of x rays). Among the thiols, disulfides, thiosulfates, and phosphorothioates prepared, the following were slightly (5 to 24% 30-day survival) radioprotective in mice: sodium S-2-(2-phenoxyethylamino) ethyl hydrogen phosphorothioate, S-2-[2-(phenylthio) ethylamino] ethyl hydrogen thiosulfate, S-2-[3-(phenylthio)propyl amino]ethyl hydrogen thiosulfate, N,N'-(dithiodiethylene) bis[3-(phenyl thio) propylamine] dihydrochloride and lithium S-2-[3-(phenylsulfonyl)propylamino] ethyl hydrogen phosphorothioate. N,N'-(Sulfonyldiethylene)bis(S-2-aminoethyl hydrogen thiosulfate), which was prepared by an aziridine ring-opening reaction, showed fair radioprotection (33% 30-day survival). (BBB)

45787 MECHANISMS OF PROTECTION AGAINST GASTROINTESTINAL AND HEMATOPOIETIC RADIATION LETHALITY BY PARABIOSIS. Carroll, H. W.; Kimeldorf, D. J. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 39: 770-6(Sept. 1969).

The mechanisms for protection through parabiosis against both the acute intestinal and hematopoietic radiation death were investigated in two separate experiments. The length of time after irradiation that the parabiosis must remain intact for protection to occur was investigated in the first experiment. The data show that if surgical separation is delayed to 48 hours postexposure,

protection against 3- to 5-day death occurs, and if delayed to 96 hours, protection against 30-day lethality also occurs. The second experiment was designed to test the quantity of whole-body radiation that one member of a parabiotic pair could receive (range 250 to 1000 R) and still provide protection to the simultaneously irradiated partner (1500 R). The results of this experiment show that over the range tested, none of the doses alters the animal's capacity to protect an irradiated partner (1500 R) against the 3- to 5-day death. Substantial 30-day survival also occurred with all the test doses employed except at the highest exposure level (1000 R). The findings are consistent with the hypothesis that protection through parabiosis against 3- to 5-day death is one of electrolyte and fluid maintenance, and protection against 30-day mortality is through transfer in peripheral blood of stem cells capable of repopulation of bone marrow. (auth)

45788 PROTECTION OF CYSTEAMINE FROM THE TERATOGENIC EFFECT OF X RAYS IN GOLDEN HAMSTERS. Kulig, Andrzej; Kowalczyk, Katarzyna; Plonkowa, Irena. Patol. Pol., 19: 379-86(Sept.-Oct. 1968). (In Polish).

The effect of ionizing radiation on golden hamster fetuses and the protection afforded by cysteamine have been studied. Doses of 70 R and 100 mg of cysteamine per kg body weight were used. Under the influence of radiation, dead fetuses and developmental anomalies of the eyeball were observed. Cysteamine, besides its protective action, probably also damages the fetuses. (auth)

45789 DIALYSABLE AGENT INVOLVED IN THE STIMULATION OF THYMIC REGENERATION FOLLOWING INJURY. Burger, M.; Knyszynski, A. (Weizmann Inst. of Science, Rehovoth, Israel). Nature (London), 223: 1165-6(Sept. 13, 1969).

It was found with in vitro and in vivo test systems that a dialyzable agent in the bone marrow of mice and rabbits stimulates proliferation of thymic cells. The in vitro test was based on ^{3}H-thymidine incorporation into DNA of thymic cells, and the in vivo test on regeneration of x-ray injured thymuses. The action of the bone marrow preparation was similar to that of intact syngeneic bone marrow cells in the regeneration of x-ray injured thymuses. (UK)

Radiation Sickness and Injuries

Refer also to abstracts 45876 and 45942.

45790 COMPLICATIONS OF RADIOTHERAPY FROM SURGICAL UROLOGICAL VIEWPOINT. Drobik, Norbert; Blaha, Herbert (Univ., Frankfurt am Main). Bruns. Beitr. Klin. Chir., 215: 56-74(Aug. 1967). (In German).

A survey is presented on surgically important radiation injury. There are early and late injuries; pathologico-anatomic changes are pointed out. Late injuries following radiation (after decades) are also described in detail. Particularly, changes of the skin, the genito-urinary system, the bowels, bone and vessels are discussed. Considering the difficulties in treating the injuries after manifestation, special attention has to be paid to prophylaxis. (auth)

45791 DISINTEGRATION OF NITROGEN NUCLEI IN AN EMULSION BY DEUTERONS DERIVED FROM THE HEPATIC AND NEOPLASTIC TISSUE OF THE GUERIN EPITHELIOMA-BEARING RAT. Wszolek, B.; Kukiel, E.; Majewski, Cz. (J. Strus Municipal Hospital, Poznan, Poland). Pol. Med. J., 7: 1442-7(1968). Translated from Patol. Pol., 19: No. 1(1968).

The purpose of this study was to ascertain whether nuclear particles other than neutrons occur in the liver and neoplastic tissue in Guerin epithelioma-bearing rats. The technique of nuclear emulsions was used. The nuclear plates were examined microscopically after a 6-week exposure and appropriate chemical processing of the emulsion. Nuclear processes induced by charged particles were recorded in the emulsions with both the substrates mentioned above. On the basis of the measurements and calculation deuteron was found to be responsible for the disintegration of the atomic nuclei. There were nitrogen nuclei deriving from the emulsion which underwent disintegration. (auth)

45792 FACTS AND THOUGHTS ABOUT THE TREATMENT OF LETHALLY IRRADIATED HUMANS. Latarjet, Raymond (Pasteur Inst., Paris). Proc. Res. Inst. Nucl. Med. Biol., No. 10, 188-94(1969).

Techniques for removing and storing human bone marrow for therapeutic use are described. Studies on irradiated mice showed that 38 of 50 animals given AET survived and that the intestinal epithelium was intact; all control animals died. Bone marrow infusions prevented hemopoietic death. Symptoms following radiation accidents to seven people exposed to 400 to 1100 rems of fast neutrons and γ rays are described in detail. Symptoms included lymphopenia, leukocytosis, chromosome aberrations in blood cells, depletion of bone marrow, and decrease of plasma proteins and amino acids. Detailed examinations of bone marrow populations in every bone of one patient were made over a period of 120 days. Treatment consisted of maintaining biochemical and nutritional equilibrium, keeping the patient under aseptic conditions, blood transfusions, administration of antibiotics, and bone marrow transfusions. Four patients were given bone marrow transfusions directly from donors without homogenization. One month after the graft the patients' bone marrow started growing and rejecting foreign bone marrow and the patients recovered. (H.L.W.)

45793 PLASTIC OPERATIONS IN TISSUE DAMAGED BY IRRADIATION. Grimm, G. Acta Chir. Plast., 10: 303-14(1968).

Tissue damage after irradiation and its sequelae are described, as well as the surgical treatment of this condition. These sequelae result from the tendency for poor healing of the wound due to inadequate blood supply and the breakdown of natural resistance to infection. Treatment of radioinjured tissues is described. Preoperative treatment was aimed at improving the general condition of the patient, such as compensating protein losses by blood and plasma transfusions, administration of vitamins, and psychological guidance. Local measures are centered on defense against infection; however, the surface flora cannot be eliminated by mechanical means or disinfectants because the affected skin is too tender, delicate, and prone to injury. If surgery is required, it is essential to remove all x-ray-damaged tissue to create a recipient bed with good blood supply for transplantation. Excision should not be limited to precancerous and cancerous tissue, but should, as far as possible, include the entire radiation-damaged skin. The choice of graft material and the amount required should be carefully planned before operation with regard to coverage of the defect immediately after the excision of the damaged tissue. If a deep excision is required that makes coverage of the resulting defect by tissue mobilized from nearby impracticable, the flap or flaps formed on remote sites should already be prepared for implantation into the defect at the time radical operation is carried out. (BBB)

Radiodiagnosis

Refer also to abstracts 45230, 45372, 45508, 45518, 45584, 45609, 45681, 45739, 45764–45767, and 45769.

45794 (ANL-7535, pp 173-4) THYROIDITIS IN A CLOSED COLONY OF BEAGLE DOGS: NONDESTRUCTIVE METHODS FOR DIAGNOSIS. Fritz, Thomas E.; Norris, William P.; Kretz, Norbert D.; Zeman, Ruth C.; Witebsky, Ernest; Kite, Joseph H. (Argonne National Lab., Ill.).

Experimental results demonstrated conclusively that the thyroid glands of beagles with thyroiditis have a biologic half-life for ^{131}I considerably shorter than the thyroids of beagles with normal glands. Since the lesions of the thyroids were moderate to severe in all these three cases, it remains to be shown that these differences from the normal are detectable in glands with incipient or mild involvement. (auth)

45795 (ORO-3350-3) MYOCARDIAL SCANNING OF MONGREL PIGS AND CHRONIC CARDIAC PATIENTS WITH ^{131}Cs IN COMBINATION WITH SELECTIVE CORONARY ANGIOGRAPHY. Annual Progress Report. Goodrich, Jack K. (Duke Univ., Durham, N. C.). Aug. 31, 1969. Contract AT(40-1)-3550. 14p. Dep. CFSTI.

Arteriographic studies were conducted on the coronary artery of pig hearts using a catheter with a partial occluding device; advantages of this method over occlusion produced by direct surgical procedures are that the pericardium is not entered and the myocardium is not disrupted. Arteriograms of 50 pigs were recorded before and after the partial occluding device was introduced. Scan-detectable myocardial infarcts developed in 33 pigs that survived the initial catheterization. Serial scans performed with ^{131}Cs of 23 pigs showed evidence of infarction at 24 to 48 hrs in the region of the partial occluding device. Findings indicated that the ^{131}Cs myocardial scan is a low-morbidity means of accurately documenting experimentally induced infarctions. A comparative study of ^{131}Cs myocardial scanning and selective coronary arteriography was made on 51 patients suspected of having heart disease. Findings indicated that the effectiveness of ^{131}Cs scanning of the human heart is severely limited by the low energy of the tracer's photon emissions; these photons are attenuated by the bony thorax that obscures a major portion of the heart. Lesions of the left ventricle may be detected with relative ease by scanning with ^{131}Cs. Advanced-degree lesions of the left heart circulation often produce abnormal scans. Low-grade lesions seldom produce defects detectable by scanning. A major disadvantage is the long period of immobility imposed on the patient by excessively low counting rates from the allowable dose of ^{131}Cs. (H.L.W.)

45796 STABILISER-FREE TECHNETIUM COLLOID. Beltran Lopez, R.; French, Rosemary J. (Royal Marsden Hospital, Sutton, Eng.). Brit. J. Radiol., 42: 633-5(Aug. 1969).

A method is described for the preparation of stabilizer-free technetium-99m colloid. Despite several drawbacks, which are currently under investigation, the preparation was used satisfactorily in over 100 patients. So far, it seems to be an important improvement in the method for clinical use. (E.R.B.)

45797 RADIOISOTOPE SCANNING OF THE LUNG IN CYANOTIC CONGENITAL HEART DISEASE. Haroutunian, Lulu M.; Neill, Catherine A.; Wagner, Henry N. Jr. (Johns Hopkins Hospital, Baltimore). Amer. J. Cardiol., 23: 387-95(May 1969).

Use of ^{113m}In-labeled ferric hydroxide was compared with that of ^{131}I-labeled serum albumin macroaggregate (MMA) for lung scanning in 20 patients with cyanosis from malformations of the heart. A dose of 300 μCi ^{131}I-MAA resulted in a total radiation dose of 0.1 rad and total lung irradiation of 1.2 to 1.8 rad. The dose to the lungs from the ^{113m}In was about 0.75 rad. In cyanotic patients with large right to left shunts significant numbers of radioactive particles reached the systematic circulation, including the cerebral vessels. Animal studies showed a safety factor of 50 in the cerebral circulation following direct injection of comparable doses into the internal carotid artery. The clinical data and the findings from lung scanning are summarized. Lung scanning was found to be safe and useful method of studying pulmonary blood flow in cyanotic patients, and good correlation was obtained with angiocardiographic findings. (BBB)

45798 STUDY OF RENOSCINTIGRAM. Miki, Makoto (Jikei Univ., Tokyo). Nippon Hinyokika Gakkai Zasshi, 60: 439-70 (May 1969). (In Japanese).

Experiments were performed in rabbits to determine the distribution of ^{203}Hg- and ^{197}Hg-Neohydrin in the body, to investigate the radiation effects of the labeled Neohydrin on the kidneys, and to evaluate the tracing ability of the renoscintigram by means of phantom experiment. Results are reviewed from 200 clinical studies in which excretory urographies and renal scannings were performed simultaneously. In addition retrograde pyelography, renal angiography, and renography were done as needed. For the scintiscanning of the kidneys 100 to 150 μCi of ^{203}Hg-Neohydrin was injected intravenously for adults except for 7 cases which received ^{197}Hg-Neohydrin. The patients were kept in prone position for an hour after the administration before they were scanned. Both ^{203}Hg-Neohydrin and ^{197}Hg-Neohydrin gave good scanning results. Uptake of RI-Neohydrin by renal tissue (renal tubular cells) was parallel to renal function, so the scanning added new clinical informations in case of destruction, displacement, or disturbance of the renal tubular cells. The scanning was a very valuable test for regional renal function. In particular, scanning was a great adjunct in evaluating the isthmus of horseshoe kidney, abnormalities due to tumor or polycystic kidney, destruction caused by renal trauma or renal tuberculosis, and parenchymal changes resulted from nydronephrosis and staghorn calculi. Even on the patients with renal insufficiency, scanning could be safely performed and it gave a great deal of information. (NSA of Japan)

45799 27th CONGRESS OF JAPAN RADIOLOGICAL SOCIETY, TOTTORI, JAPAN, APRIL 6-9, 1968. Hoshino, Fumihiko; Tobe, Tatuo. Nippon Igaku Hoshasen Gakkai Zasshi, 28: No. 6, 321p. (Sept. 1968). (In Japanese). (CONF-680463).

At the 27th General Assembly of the Japan Radiological Society, some congress- and special lectures and symposia were delivered, and 429 papers were presented. In the symposium the present situation of coronary angiography was reported, and the fact that the magnification of graphic images of alveolus and bronchus with atomized contrast media is very useful for diagnosing lung diseases. That radiotherapy affects the environment of tumors, but this change is not unfavorable to tumors, that a radioresistant cell population develops after repeated irradiations, that the time-dose relationship in radiotherapy is related to the tumor-host relations, and that radiotherapy requires close cooperation of radiotherapists with radiophysicists, were also discussed in lectures. Summarizing the papers, in the field of radiophysics, many papers on dosimetry of high energy electron beam and x ray were presented, and the calculation of dose distribution with the electronic computer was seen as a new tendency. In radiobiology, there were many presentations on radiosensitizers, irradiation in hyperbaric oxygen, and radioprotectors. Considerable attention was given to radiation injury to brain tissue. In x-ray diagnosis, a great many presentations on selective angiography in thoracic and abdominal regions with x-ray TV, and reports on mass examination of gastric diseases were seen. In radiotherapy, there were many reports on high energy electron beam irradiation, and a surgical direct-to-lesion irradiation with electrons was newly reported. In nuclear medicine, many papers on scinticamera use were presented and a tendency towards function test of organs was recognized. (auth)

45800 ^{113m}In AS A SCANNING AGENT. Andrews, J. T.; Steven, L. W. (Royal Melbourne Hospital). Australas. Radiol., 13: 114-19(Feb. 1969).

A brief description is given of the preparation and uses of compounds of ^{113m}In for scanning brain, liver and reticulo-endolethium, lung, kidney and blood pool. Some modifications to methods of preparation are reported. A 25 mCi ^{113}Sn–^{113m}In generator was used in clinical trial involving 58 scans of which 29 were of the lung and 17 of the brain. ^{113m}In is considered a routine radioisotope and is favored for lung and liver scans. ^{99m}Tc is still preferred for brain scans, except in special circumstances. (auth)

45801 ^{252}Cf NEUTRON SOURCES FOR MEDICAL APPLICATIONS. Boulogne, A. R.; Evans, A. G. (E. I. du Pont de Nemours and Co., Aiken, S. C.). Contract AT(07-2)-1. Int. J. Appl. Radiat. Isotop., 20: 453-61(June 1969).

Californium-252 neutron sources are beiag prepared to investigate the value of this radionuclide in diagnosing and treating diseases. A gram of ^{252}Cf emits 2.34×10^{12} neutrons per sec through spontaneous fission. A source resembling a cell-loaded radium needle was developed for neutron therapy. Four micrograms of ^{252}Cf were electrodeposited on a platinum–iridium wire, 0.51 mm in dia. and 20 mm in length, and the wire was doubly encapsulated. Since therapy needles are normally implanted in the body, very conservative design criteria were established to prevent leakage of radioactive material. A more intense source, containing 100 μg of ^{252}Cf was prepared for neutron radiography experiments. This source is pelletized ^{252}Cf oxide in a platinum metal matrix doubly encapsulated in stainless steel. The active source volume is approximately 6 mm^3. Methods are being developed to prepare very intense californium sources that could be used for neutron radiography and for diagnosis by activation analysis. (auth)

45802 DIAGNOSTIC ADVANTAGES OF NUCLEAR MEDICINE FOR LOCALIZATION. pp 180-216 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of 40 papers are presented. The diagnostic value of various radioisotopes is demonstrated for the localization of pathologic processes in the brain, lungs, spinal cord, spleen, biliary system, adrenal glands, and pancreas. Measuring techniques, scintigraphy, and data evaluation are discussed. (H.B.G.)

45803 PRODUCTION OF X-RAY FILMS AND THEIR DIAGNOSTIC EVALUATION. pp 16-29 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of eleven papers are presented. Conditions for obtaining optimal diagnostic x-ray pictures are examined theoretically with the modulation transfer function and by experimental studies. Discussed are the effect of dose rate, film size, and image intensifier. (H.B.G.)

45804 DIAGNOSTIC VALUE OF MAMMOGRAPHY. pp 166-80 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of thirteen papers are presented. The diagnostic values of both mammography and thermography in breast tumors are discussed. Clinical evaluation of mammography for differential diagnosis and early diagnosis of mammary tumors is given. (H.B.G.)

45805 RADIATION INDUCED HEMATOLOGICAL CHANGES IN THE PAST AND THE PRESENT. pp 162-6 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of five papers are presented. Possibilities and limitations of radiological diagnosis are discussed with respect to fractures of the skull base, lung tumors, adrenal tumors, and disturbances of the biliary system. (H.B.G.)

45806 SESSION ON KIDNEYS. pp 149-56 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of eight papers are presented. Glomerular and renal functions are evaluated with chemical compounds labeled with various radioisotopes. Application of renography and differential-diagnostic possibilities are discussed. (H.B.G.)

45807 SESSION ON THYROID. pp 141-9 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of five papers are presented. Studies of iodine-131 metabolism in the thyroid are presented. Diagnostic procedures for thyroid adenomas are evaluated. (H.B.G.)

45808 DYNAMIC DIAGNOSIS IN NUCLEAR MEDICINE. pp 135-40 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of seven papers are presented. Dynamic studies with radioisotopes were performed. Glucose metabolism was studied with carbon-14 labeling, hemodynamics were evaluated with iron-59, and thyroid function was assessed with iodine-131. (H.B.G.)

45809 SPECIAL SESSION ON PRODUCTION OF X-RAY FILMS AND THEIR EVALUATION. pp 110-24 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of fifteen papers are presented. To obtain a maximal diagnostic interpretation of x-ray films, various tactical procedures are discussed. Tomography, low energy x rays, brief x ray pulses, use of television equipment, and image intensifiers are emphasized. (H.B.G.)

45810 LUNG SCANNING IN THE DIAGNOSIS AND MANAGEMENT OF PULMONARY EMBOLISM. Morris, John (Royal Prince Alfred Hospital, Camperdown, N. S. W.). Australas. Radiol., 13: 88-92(Feb. 1969).

Results of perfusion lung scanning are given for 360 patients in whom pulmonary embolism was finally diagnosed out of 1000 referred. Intravenous doses of 100–300 microcuries of ^{131}I labeled macroaggregated albumin or 1.5 millicuries of ^{113m}In labeled $Fe(OH)_3$ were given. The technique is simple and safe for detecting abnormalities in regional pulmonary blood flows. Rectilinear scanning or gamma camera studies with multiple views of both lungs give the most accurate detection of defects. The earlier the scan examination is performed after occurrence of the pulmonary embolus, the more likely it is to reveal a perfusion defect. Most accurate interpretation requires careful correlation with clinical, radiological, and respiratory function data. (auth)

45811 DETERMINATION OF BRAIN DEATH BY ISOTOPE ANGIOGRAPHY. Goodman, Julius M.; Mishkin, Fred S.; Dyken, Mark (Indiana Univ., Indianapolis). J. Amer. Med. Ass., 209: 1869-72(Sept. 22, 1969).

In more than 500 studies of cerebral perfusion by isotope angiography with the scintillation camera, visualization of cerebral arteries and venous sinuses invariably occurred, except in the three patients studied with suspected brain death. Each of these patients was deeply comatose, with dilated, fixed pupils, and required artificial ventilation. At autopsy their brains had severe autolytic changes (respirator brain). This preliminary experience suggests that an isotope angiogram showing no evidence of cerebral vasculature would be valuable in corroborating the clinical impression of brain death. (auth)

45812 CHEMICAL TESTING OF OCCULT BLOOD IN FAECES: "HAEMATEST", "OCCULTEST", AND GUAIAC TESTING CORRELATED WITH ^{51}Cr ESTIMATION OF FAECAL BLOOD LOSS. Humphery, Timothy J., Goulston, Kerry (Royal Prince Alfred Hospital, Sydney). Med. J. Aust., 1: 1291-3(June 21, 1969).

Two tablet tests, Occultest and Haematest, and the guaiac solution test for detection of fecal occult blood were evaluated in 39 healthy male subjects for 21 consecutive days. Diet was unrestricted during the first seven days, but for days 8 to 21 the diet excluded salicylates, alcohol, meat (except pork), soup (meat), uncooked vegetables and turnips. During the unrestricted diet period the incidence of false positive results was 90% for Occultest, 35% for Haematest and 22% for guaiac testing. After the diet had been restricted for 3 days, false positive results were 58%, 3% and 3% respectively. On days 15, 16 and 17, each subject ingested 15 ml. of ^{51}Cr labeled blood and chemical testing results were compared with the amount of blood estimated by the radioisotopic technique. In 80 fecal specimens containing less than 5.1 ml. of blood, 65% showed positive results for Occultest, 18% for Haematest and 9% for guaiac testing. In 100 specimens containing more than 5 ml. of blood, the percentages of positive results were 93%, 51% and 69% respectively. In 40 specimens containing more than 10 ml. of blood per 100 gm. of feces, the percentages were 98%, 58% and 83% respectively. In detection of blood in feces, Occultest is too sensitive and is valueless; Haematest and guaiac testing are valuable only if used after a restricted diet period of three days, and then the guaiac solution test is the more satisfactory and is recommended. (Australia)

45813 OBSERVATIONS ON THE CLINICAL USE OF PANCREATIC SCINTIGRAPHY USING METHIONINE-^{75}Se. Roncari, G.; Mombelli, L.; Bergonzi, M. (Univ., Milan). Radiol. Med., 60: 635-49(July 1969). (In Italian).

The value and the limits of pancreatic scintigraphy with methionine-^{75}Se are discussed on the basis of the results of a first clinical-diagnostic utilization of the method. A varied case-list of pancreatic affections and a group of healthy subjects were studied, adopting not only the conventional examination technique but also that permitting radioisotopic subtraction of the hepatic radioactivity. The morphological variations of the healthy pancreas and the most typical patterns associated with the various affections of the organ are examined. It is concluded that, in spite of the low specificity of the alterations observed in the various pathological states, scintigraphy with methionine-^{75}Se is undoubtedly a valuable aid in the diagnosis of pancreatic disorders. As for radioisotopic subtraction, the authors believe that it represents a substantial progress in scintigraphic study of the pancreas. It was found especially useful in patients with hepatomegaly and with functional exclusion of the pancreas. (auth)

45814 EXTERNAL COUNTING AND SCINTIPHOTOGRAPHY IN RABBITS WITH ARTHRITIS. Sholkoff, Stephen D.; Glickman, Morton G.; Schachter, Julius; Rowland, Malcolm (Univ. of California, San Francisco). Arthritis Rheum., 12: 220-7(June 1969).

Anger camera scintiphotography and external counting, using pertechnetate-^{99m}Tc, was used to study bedsonia arthritis in rabbits. The rabbits were infected with bedsonia organisms by intraarticular injection into one knee joint, and were evaluated by clinical, roentgenographic, and scintiphotographic examinations over a period of 3 weeks. The Anger scintillation camera was equipped with a high-speed automatic digital printer, and a 4000-parallel-hole, low-energy collimator. Scintiphotographic examinations were performed after intravenous injection of 500 μCi of $^{99m}TcO_4$ at varying intervals after infection. The crystal was split electrically so that each knee was counted separately. Scintiphotographic techniques demonstrated evidence of inflammation before joint inflammation was seen clinically. No false positive or false negative results were obtained. The intensity of local involvement by inflammation could be graded objectively by external counting and scintiphotographs. On serial studies, scintiphotographs and ratios of counts collected from the knees correlated well with each other and with the changing clinical state. It was concluded that ^{99m}Tc scintigraphy is the most valid, simple method of evaluating early stages of arthritis and its changing state. It is useful in animal research, where objectivity is essential and a clinical history is not possible. (BBB)

45815 PROCEEDINGS OF THE 5th ANNUAL MEETING OF THE JAPANESE SOCIETY OF NUCLEAR MEDICINE, AUG. 29, 30, 1965, KYOTO, JAPAN. VOLUME 5. Jap. Nucl. Med., 5: 1-107(1966). (CONF-650851).

Summaries are included for 135 papers covering uses of radioisotopes in the diagnosis of various diseases. (C.H.)

45816 VALUE OF MASS MINIATURE RADIOGRAPHY FOR EARLY DIAGNOSIS OF LUNG CANCER. Westrych, O.; Paulo, J. (Province Tuberculosis Outpatient Clinic, Katowice, Poland). Pol. Med. J., 7: 1097-1104(1968).

Translated from Gruzlica Choroby Pluc, 35: No. 11(1967).

The increasing incidence of lung cancer recognized in most cases at a stage precluding effective treatment involves the necessity of finding methods of early detection of this disease. Mass miniature radiography of the chest repeated at relatively short time intervals in high-risk groups of the population is suggested as the method meeting these demands. In Poland the system of mass radiography stations fulfills this postulate. (auth)

45817 PERFUSION SCINTIGRAPHY OF THE LUNGS. Feine, U. (Univ., Tuebingen, Ger.). Ger. Med. Mon., 13: 549-51(Nov. 1968).

Use of various radioisotopes for lung scanning is reviewed. Scintigraphic visualization of the lungs with radioisotopes may be achieved by the inhalation of labeled gases or aerosols or intravenous injection of labeled particles which accumulate in the terminal capillaries of the pulmonary circulation. The possibilities of introducing radiogold-charcoal particles into the lesser circulation as a method of pulmonary scintigraphy have been explored, but the use of heat-denatured macroaggregated albumin particles labeled with ^{131}I has found more universal clinical appli-

cation. Recently, other particles labeled with ^{99m}Tc (half-life 6 hr) and ^{113m}In (half-life 1.7 hr) have been used. These nuclides are prepared from longer-living parent substances and, because of their short half-life, can be used in large doses and can again be injected within a few hours. Pulmonary perfusion scintigraphy is generally performed after injection of 100 to 200 μCi of ^{131}I-labeled macroaggregated human serum albumin into the left antecubital vein during inspiration, with the patient recumbent. The scintigraphic recording can be made at once, since the particles accumulate on their first passage through the pulmonary circulation and are broken down after about 6 hr. The thyroid gland must be blocked with inactive iodine before pulmonary scintigraphy with ^{131}I. The radiation dose corresponds roughly to that of 1 or 2 chest radiographs. The pulmonary perfusion scintigram demonstrates the vascular pattern existing in the various lung segments at the moment of intravenous injection. To evaluate this pattern quantitatively a method is used which gives the total impulse count separately for two or more areas of each lung and expresses the ratio between them. (BBB)

45818 QUANTITATED SCINTILLATION SCANNING FOR THE MEASUREMENT OF LUNG PERFUSION. Garnett, E. S. (Royal South Hants Hospital, Southampton, Eng.); Goddard, B. A.; Machell, E. S.; Macleod, W. M. Thorax, 24: 372-3(May 1969).

A radioisotope method using quantitated lung scans is described for the accurate proportioning of lung perfusion. The results obtained by this method were compared directly with those obtained from bronchospirometry, and with results of other isotope methods employing ^{15}O, ^{133}Xe, ^{135}Xe, and ^{85}Kr. The method used involved injection of macroaggregates of ^{131}I-labeled human serum albumin into a peripheral vein and localization of the accumulation of radioactivity in the lung with a scintiscanner. The concentration of radioactively labeled micro-emboli in the various parts of the lung should be directly related to pulmonary blood flow. Human serum albumin, labeled with 300 μCi ^{131}I, was macroaggregated by heating at its isoelectric point. Scans were made in both the prone and supine positions immediately after injection of the macroaggregates. Twenty patients suffering from carcinoma of the bronchus or bullous emphysema were studied. The percentage of the dose of ^{131}I-macroaggregated albumin that accumulated in the right lung ranged from 10 to 83%. The percentage oxygen uptake per min in the right lung ranged from 20 to 86%. Comparison between the results obtained from oxygen uptake and the percentage of the dose of ^{131}I macroaggregated albumin that accumulated in the right lung gave a correlation coefficient $r = +0.93$. Information about local perfusion was interpreted from the scan that was not always obtainable from pulmonary angiography. Such detailed information cannot be obtained from ^{133}Xe studies even when batteries of scintillation counters are used. (BBB)

45819 THE DETERMINATION OF REGIONAL CEREBRAL BLOOD FLOW BY MEANS OF WATER LABELED WITH RADIOACTIVE ^{15}O. Ter-Pogossian, Michel M.; Eichling, John O.; Davis, David O.; Welch, Michael J.; Metzger, Judith M. (Washington Univ. School of Medicine, St. Louis). Radiology, 93: 31-40(July 1969).

A method for the in vivo determination of regional cerebral blood flow using water labeled with ^{15}O as a diffusible indicator is described. In this method a small volume of blood labeled with ^{15}O either in the form of ^{15}O-water or ^{15}O-oxyhemoglobin is rapidly injected into the internal carotid of a patient, and the subsequent egress of radioactivity from the brain is measured, as a function of time, by means of six collimated scintillation probes placed over the patient's skull. Regional cerebral blood flow and regional oxygen utilization can be determined from the rate of washout of the radioactive water and from the amount of labeled water regionally formed subsequent to the injection of ^{15}O-oxyhemoglobin. This approach offers the following advantages over the use of radioactive inert gases: tissue-blood partition coefficients are easier to determine for water than for inert gases; water is less soluble in lipids than inert gases commonly used for blood flow studies; and the injection of ^{15}O-oxyhemoglobin allows a measure of regional cerebral oxygen utilization. It appears, on the basis of a limited number of human studies, that regional oxygen utilization is not always proportional to regional cerebral blood flow. (auth)

45820 EVALUATION OF RENAL FUNCTION, USING A SCINTILLATION CAMERA AND COMPUTER. Loken, Merle K.; Linnemann, Roger E.; Kush, George S. (Univ. of Minnesota Hospitals, Minneapolis). Radiology, 93: 85-94(July 1969).

Scintillation camera renography with computer analysis of the data is a new technique offering specificity, versatility, and speed in studying dynamic renal function with ^{131}I-hippuran. The combination of rectilinear chart recordings, serial scintiphotographs, and compartmental computer-plotted renograms is a significant advance in the qualitative interpretation of renal function. (auth)

45821 GRID CHOICE IN HIGH-KILOVOLTAGE 70-MM RADIOGRAPHIC SPOT-FILMING. Hayt, David B.; Simon, Donald F.; Collica, Carl J. (Misericordia-Fordham Hospitals, Bronx, N. Y.). Radiology, 93: 135-8(July 1969).

Comparative 120 kVp spot-films were obtained, utilizing six different grids or combinations of grids to show changes in film quality at varying thicknesses of gastrointestinal radiographic phantoms in the abdomen. A tabular evaluation of the film quality and corresponding radiation dosage measurements and a tabular evaluation of the corresponding quality of the televised image-amplified fluoroscopic image are presented. It was concluded that: there is little difference in film quality on 70-mm abdominal spot radiography with thin or average patients regardless of the grid employed; greater differences in film quality are seen with different grids when the phantom thickness simulates heavy patients; the radiation dosage using more effective grids is not particularly increased with thin or average patients but is significantly greater with heavier patients; the televised image quality deteriorates with more effective grids, particularly with heavier patients; and the choice of the grids depends on a balance between grid effectiveness for filming, radiation dosage, and the television image but cannot really be evaluated properly except in heavier patients. (C.H.)

45822 PROGNOSIS IN PATIENTS WITH METASTATIC LIVER DISEASE DIAGNOSED BY LIVER SCAN. Mansfield, Carl M.; Kramer, Simon; Southard, Martha E.; Mandell, Gerald (Jefferson Medical Coll., Philadelphia). Radiology, 93: 77-84(July 1969).

The records of 238 patients whose scans were read as compatible with metastatic disease were reviewed. All the patients had proved cancer. When the appearance of the liver scan (subjective and semiquantitative) was compared with survival, there appeared to be a trend toward decreasing survival with increasing abnormality of the scan. Other parameters such as liver enlargement, abnormal chemistries, extrahepatic metastases, and primary site did not seem to affect survival appreciably. The exception was lung cancer, in which the presence of extrahepatic metastases seemed to have an effect on survival, but the number of cases was too small to attach statistical significance. It is understood that the subjective evaluation would be purely individualized, but it may be possible to use the semiquantitative method to determine prognosis. (auth)

45823 HYPERTHYROIDISM. Markovits, E. (Ospedale Civile Luvini, Varese, Italy). Panminerva Med., 11: 329-34 (June 1969).

The pathology, diagnosis, and therapy of hyperthyroidism in man are reviewed. The use of ^{131}I uptake studies in diagnosis and radiotherapy using interstitial ^{131}I are discussed. (C.H.)

45824 THE QUANTIFICATION OF GLOMERULAR FILTRATION FOR EACH KIDNEY SIMULTANEOUSLY BY A RADIOISOTOPIC TECHNIQUE EMPLOYING MEGLUMINE DIATRIZOATE-^{131}I. Meschan, I.; Watts, F. C.; Maynard, C. D.; Armas, C. R.; Schmid, H. E.; Boyce, W. H. (Wake Forest Coll., Winston-Salem, N.C.). Australas. Radiol., 13: 182-92(May 1969).

Meglumine diatrizoate-^{131}I (Renografin-^{131}I) renogram has been extensively quantified in 121 patients with diverse diagnoses. The excretory phase of the renogram beyond the first five-minute interval represents an analog curve following a single exponential equation. Both in the normal as well as many abnormal states, meglumine diatrizoate-^{131}I closely follows inulin clearance and hence may be assumed to represent a good test for glomerular filtration. The equation for the determination of clearance from the renogram is given as Clearance MGD-^{131}I $= (1.82 \times 10^3)/T_{\frac{1}{2}}$. For this compound clearance can be determined for each kidney directly from the renogram provided that the patient is properly primed, hydrated, equilibrated and stabilized comfortably in the supine position for 45 minutes prior to the test period; that the renogram is analyzed five minutes after intravenous injection, and that the urine flow lies between 1.0 and 9.0 ml./min. and the urinary tracts are not obstructed from kidney to bladder. (Australia)

45825 EXPERIENCE WITH A GAMMA CAMERA. Sephton, R. G. (Cancer Inst., Melbourne); Steven, L. W.; Andrews, J. T. Australas. Radiol., 13: 230-4(May 1969).

A test of limited duration was made of an Anger gamma camera. The crystal was illuminated at the field centre with a highly collimated 140 kV gamma beam. This test yielded an inherent resolution dimension measurement of 1 cm for the camera. A comparison was made of the ability of the camera and of a 3 inch detector scanner to detect 2, 1.5 and 1 cm cubic blocks on the bottom surface of a 10 cm square volume of Tc-99 m liquid 2.7 cm in depth. The level of nearest collimator approach in both cases was 7 cm from these details. On the whole these seemed little to choose between scanner and camera results for equal investigation times. Twenty-

four clinical investigations including 7 brain, 5 liver, and 5 lungs, were conducted and the results are described. The camera is probably 3 times faster than the typical scanner for equivalent results, but its limited field size inhibits its versatility. It is easy to operate if equipped with the auxiliary storage display. The camera offers an unmatched facility when dynamic studies become prominent. (Australia)

45826 STATUS OF RESEARCH IN DIAGNOSTIC RADIOLOGY: A REPORT BY THE RADIOLOGY TRAINING COMMITTEE OF THE NATIONAL INSTITUTE OF GENERAL MEDICAL SCIENCES (NIH). Chamberlain, Richard H. Bethesda, Maryland, National Institutes of Health, 1967. 142p.

The present status of research in diagnostic radiology in the U.S.A. is surveyed, with attention to radiation health considerations, automation, and computer applications, and radioisotope techniques. Much research in this field is concerned with greater safety of diagnostic radiography for both patient and radiologist. This research is divided into 3 general categories: studies of the effects of small doses of ionizing radiation given during short time periods to experimental animals; assessments of radiation doses delivered to various tissues, including certain critical tissues, for instance, the gonads, of patients undergoing diagnostic radiologic examinations; and the development of techniques and equipment by which diagnostic radiation doses may be reduced. (BBB)

45827 AVOIDANCE OF PYROGEN REACTIONS WITH RADIOISOTOPE PREPARATIONS. Wright, F. W. (Churchill Hospital, Oxford). Brit. J. Radiol., 42: 475(June 1969).

Radioisotope preparations sterilized (moist heat) in standard 20 ml blood bottles with metal screw caps and rubber washers tended to produce rigors and pyrogen reactions in patients. Animal experiments did not lead to definite conclusions as to the causative factor; however, capping of the bottles with aluminum foil before screwing on the cap has eliminated patients reactions. Reactions to rubber have been shown previously and this is thought to be an important factor. (C.O.)

45828 ISOTOPIC EXPLORATION OF THE THYROID IN CLINICAL MEDICINE. Perez, R. (Hopital Americain, Neuilly, France). pp 115-56 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).

The place of radioactive iodine in the investigation of thyroid function can be understood by considering the various steps in iodine metabolism. The overall measurement of cervical radioactivity, commonly called the thyroid uptake curve, is the usual clinical measurement. The principles of the method and the results obtained are discussed. The combination of this investigation with the chemical estimation of the plasma protein bound iodine and measurement of the achilles tendon response gives in most cases adequate information for the diagnosis of common conditions of the thyroid. Thyroid scanning is the usual ancillary method of investigating the morphology of the gland. Thyroid scanning has constituted an important advance in the knowledge of thyroid nodules and ectopic thyroid tissue. When routine methods of isotopic investigation encounter particular difficulties of interpretation, due essentially to variations of the intra- and extra-thyroid iodine pools or hormonal disturbances, special isotopic techniques may be necessary to investigate particular steps in the metabolic iodine pathway. These methods are reviewed. (95 references.) (auth)

45829 THE STUDY OF CARDIO-PULMONARY FUNCTION USING RADIOISOTOPES AND EXTERNAL COUNTING. de Vernejoul, P. (Service Hospitalier Frederic-Joliot, Orsay, France). pp 3-47 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).

The development of radioisotope scanning techniques for use in the study of cardio-pulmonary function by external counting is discussed. Two types of methods examined include that based on the kinetic study of cardiac and pulmonary functions and morphological studies. (83 references.) (C.H.)

45830 LES ISOTOPES: APPLICATIONS BIOCLINIQUES. (Isotopes: Bioclinical Applications). Monographie Annuelle de la Societe Francaise de Biologie Clinique, 1968. Paris, l'Expansion Scientifique Francasie, 1967. 351p.

Separate abstracts were prepared on 12 chapters that review uses of radioisotopes in clinical studies. (C.H.)

For abstracts of individual chapters see: 45615–45620, 45828, 45829, 45831–45834.

45831 MORPHOLOGICAL AND FUNCTIONAL ASSESSMENT OF THE KIDNEY. Raynaud, C. (Service Hospitalier Frederic-Joliot, Orsay, France). pp 49-81 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).

The use of substances labeled with radioisotopes has resulted in the simplification of some of the techniques of renal exploration and the development of new techniques. Four techniques discussed include: methods of measuring glomerular filtration and renal blood flow; the radioisotope renogram as a functional test to provide extremely useful information in the assessment of hypertension due to unilateral renal disease and in the detection and follow up of impaired urinary excretion; the use of radioisotope scans for the diagnosis of various pathological processes, and the localization of the position and size of these areas, such as trauma to the kidney; and the renal Hg uptake, which depends upon the functional state of the kidney. It is easily measured by external counting and the functional state of each kidney can be measured, thus avoiding selective catheterization. This is of value whenever unilateral renal disease is suspected. It is useful diagnostically, in the assessment of the extent of the lesion, in indicating the state of the other kidney, and in following functional changes which may occur in either kidney. (80 references) (C.H.)

45832 LIVER AND SPLEEN SCANNING. Parmentier, C.; Askienazy, S. (Institut Gustave-Roussy, Villejuif, France). pp 83-114 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).

The radioisotope scanning of thick organs such as the liver and spleen introduces particular difficulties due to the inefficiency of the collimator which is incapable of analyzing the whole thickness of the organ with the same efficiency. Liver scanning is carried out using ^{198}Au colloid and selective uptake of the colloid by the Kupfer cells facilitates examination at multiple locations. This is necessary, taking into account the characteristics of the collimators in order to explore as much of the parenchyma as possible. The left lobe remains, however, difficult to interpret. Liver scanning is of value in the assessment of abdominal trauma and in the search for parasitic infestations, its main application, however, is in the field of cancer diagnosis and localization. The presence or absence of metastases largely determines the success or failure of treatment. In addition to this, progress in the treatment of metastases may occur as a result of the information derived from scanning. Spleen scanning is simple to carry out using a mercury compound, B.M.H.P. As for liver scanning, multiple factors are essential for adequate interpretation of the scans. The information derived from the examination may provide, in addition to the morphological appearance of the organ, evidence of splenic involvement by lymphoma or leukemia. The morphological appearance is of considerable importance because, contrary to previously held ideas, a spleen which is not enlarged to percussion or palpable is not necessarily normal. Conversely, a palpable spleen may well be normal. As it has become increasingly important to detect splenic involvement in the lymphomas, a spleen scan should be part of the routine investigation of these conditions. The scanning of thick organs may progress along the following lines: the reduction of the body dose by using short lived isotopes; improvement in the quality of the information derived by developing new collimeters and improved numerical methods; and improvement in the treatment of the information by using computers. (60 references.) (auth)

45833 THE USE OF RADIOISOTOPES IN THE INVESTIGATION OF THE CEREBRAL CIRCULATION AND MEASUREMENT OF THE CEREBRAL BLOOD FLOW. Bes, A.; Marc-Vergnes, J.-L. (Faculte de Medecine, Toulouse). pp 321-47 of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).

From the practical point of view the use of nondiffusible tracers such as HSA labeled with ^{131}I in the study of the cerebral circulation is of particular interest in the investigation of arteriosclerotic and focal cerebral lesions. This is because the technique may be carried out in conjunction with arteriography which is a perfected method of functional investigation. From the research point of view, the method of Kety and Schmidt, together with its modifications, remains a classical method of reference for other techniques of measuring cerebral blood because of its accuracy. Since the results give the cerebral oxygen consumption, these techniques are at the moment the most satisfactory expressions of the metabolism of the brain. It is likely that the method of Lassen and Ingvar for investigating regional cerebral blood flow by injecting an inert and diffusible radioactive tracer into the carotid will undergo considerable development. Veall's inhalation method may result in the development of a useful routine technique for functional investigation of the brain. It is evident that radioisotope scanning is becoming increasingly important in the measurement of cerebral blood flow and circulation. Among the most interesting recent developments is the measurement of regional blood flow, which has already given valuable results concerning the physiology and physiopathology of the cerebral circulation. (74 references.) (auth)

45834 ISOTOPIC DISTRIBUTION. Vidon, N.; Cremer, M.; Bernier, J.-J. (Hopital Saint-Lazare, Paris). pp 289-319

of Les Isotopes: Applications Biocliniques. Paris, l'Expansion Scientifique Francaise, 1967. (In French).

In situations where there is a nutritional disorder without associated water and electrolyte changes, the use of radioisotopes allows the body composition to be determined. The method is based on the calculation of total body water, blood volume, and exchangeable sodium and potassium by means of isotope dilution. A computer program for calculating the various tissue compartments is proposed. This program has been used in the study of 20 controls, five patients with muscular atrophy, 13 obese subjects, and 55 cases of weight loss from various causes. The results suggest that whatever the nutritional state there is relatively little variation of exchangeable sodium (in cases of weight loss a relative excess is seen). The protein-rich tissues commonly show the most change in periods of weight loss. The method allows useful individual comparisons to be made, and the effect of treatment methods to be assessed. It is especially valuable as a control for regimes of weight reduction by either diet or medication. (13 references.) (auth)

Radiotherapy

Refer also to abstracts 45584, 45609, 45664, 45740, 45743, 45748, 45751, 45754, 45757, 45815, 45926–45930, 45934, 45936, 45938, 45941, 45944, and 45945.

45835 (ANL-7535, pp 45-9) NEUTRON THERAPY OF CANCER: PHYSICAL ASPECTS. Frigerio, Norman A.; Shaw, Michael J.; Seiler, Joann A. (Argonne National Lab., Ill.).

Intermediate-energy neutrons are more effective for capture and conversion therapy than reactor, epithermal ones, despite the limitations of present equipment. With improvements to be expected from newly available equipment, and under the guidance of extensive Monte Carlo computations, therapeutic ratios in excess of 20 can be anticipated for capture therapy, as contrasted to about 2 for fast neutron or conversion therapy. Thus, it appears that the physical problems surrounding neutron therapy are well in hand and that chemical problems of obtaining adequate ^{10}B or ^{235}U tumor concentrations are now major limitations to the progress of this development. (auth)

45836 TREATMENT OF TUMOURS OF THE UPPER JAW. Lederman, M.; Busby, E. R.; Mould, R. F. (Royal Marsden Hospital, London). Brit. J. Radiol., 42: 561-81(Aug. 1969).

Based on a study of a series of 715 tumors of the upper jaw seen in the Radiotherapy Department of The Royal Marsden Hospital during the period 1933 to 67, observations are made on the anatomy and pathology of these tumors. Reference is also made to the attempt to classify these tumors according to the TNM system. The basis of the treatment policy adopted is a combination of pre-operative radiation followed by surgery. A detailed account is furnished of the preparation and care of the patient undergoing radiotherapy and the possible complications that may arise and methods for their avoidance. The techniques of telecobalt therapy are discussed and illustrated, the use of the techniques being related to the classification system advocated. (auth)

45837 SESSION OF RADIATION SPECIALISTS: EVALUATION OF DATA. pp 38-51 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of thirteen papers are presented. The role of the computer is discussed with respect to therapeutic dose calculations for malignant stomach ulcer, thyroid tumors, and gynecological malignancies. (H.B.G.)

45838 MALIGNANT LYMPHOMAS. pp 63-71 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of six papers are presented. Possibilities and limitations are discussed for both radiation treatment and chemotherapeutic treatment of malignant lymphomas. (H.B.G.)

45839 SESSION ON LYMPHOGRANULOMATOSIS. pp 71-8 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of six papers are presented. Localized Hodgkin's disease is discussed with respect to surgical intervention, histology, injection of radioactive material into the lymph vessel, and epidemiology. Lymphoscintigraphy for malignant diseases, with emphasis on hemoblastosis, is evaluated. (H.B.G.)

45840 SESSION ON RETICULOSIS. pp 73-83 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Reticulum cell sarcoma is discussed for the reticuloendothelial system, especially in the head and neck region. The effect of age on radiotherapeutic measures is evaluated. (H.B.G.)

45841 SESSION ON ENDOLYMPHATIC RADIOISOTOPE THERAPY. pp 83-7 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Endolymphatic injection of radioisotopes is discussed with respect to diagnosis and therapy of malignant lymphomas. Problems of dosimetry and the effects of external radiation on human serum albumin are evaluated. Summaries of four papers are presented. (H.B.G.)

45842 TUMORS OF THE MOUTH, THE LARYNX, AND THE PHARYNX. pp 103-10 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of eight papers are presented. Both surgical and radiological treatment are evaluated for carcinomas of the mouth, larynx, and pharynx. Methods and problems of tumor classification and clinical evaluation problems are discussed. (H.B.G.)

45843 SPECIAL SESSION ON CLINICAL RADIOBIOLOGY. pp 125-35 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of thirteen papers are presented. Possibilities and limitations are discussed for chemotherapy and radiotherapy of tumors. Various biological parameters were used such as electrocardiogram, amino acid metabolism, function of small intestine, activity of the retina, DNA content, and distribution of iron. (H.B.G.)

45844 TUMORS OF MOUTH, LARYNX, AND PHARYNX. pp 157-61 of Deutscher Roentgenkongress 1968. Gauwerky, Friedrich (ed.). Stuttgart, Georg Thieme Verlag, 1969. (In German).

From German Roentgen Congress, Hamburg, Germany. See CONF-680656.

Summaries of eight papers are presented. Teletherapy especially with cobalt-60 gamma radiation and bremsstrahlung radiation is discussed. Dosimetry problems and possible injuries to the eye following therapy for mouth and pharynx carcinomas are evaluated. (H.B.G.)

45845 UPTAKE OF COLLOIDAL RADIOACTIVE YTTRIUM BY SYNOVIAL MEMBRANE. Webb, F. W. S.; Lowe, J.; Bluestone, R. (Royal Postgraduate Medical School, London). Ann. Rheum. Dis., 28: 300-2(May 1969).

The possibility of using ^{90}Y to treat synovial effusions in rheumatoid arthritis was investigated in rabbits. The physical properties that favor this isotope over ^{198}Au are discussed. The resin colloid of ^{90}Y was injected into the knee joint of the rabbits with normal and arthritic knee joints. Between 100 and 1 mCi of the colloid was injected. The animals were killed 24 hr later. The secondary radiation from the ^{90}Y (bremsstrahlung) allowed its easy localization by external scanning. Scanning showed that 24 hr after injection the ^{90}Y remained localized to the injected joint. No evidence of radioactivity could be found elsewhere in the rabbit; in particular, there was no external scanning evidence of activity over the groin lymph nodes or over the liver. Very small amounts of activity were detected in the animals' blood, urine, and feces. Total activity in the blood amounted to less than 0.2% of the injected dose, and the 24 hr collections of urine and feces contained less than 0.4 and 0.13% respectively. Autoradiographs of the synovial membrane showed even distribution of radioactivity in the cells of the synovial membrane itself. Radioactivity was dense over the cytoplasm of the synovial cells, whereas the nuclei were free of activity, showing that phagocytosis by the synovial cells is responsible for the uptake of the ^{90}Y colloid. This colloid resin of ^{90}Y may be considered for intra-articular injection, when radiation ablation of synovial membrane is wanted in arthritic patients. (BBB)

45846 EFFECT OF THYROID ABLATION ON DYSTHYROID EXOPHTHALMOS. Boyle, I. T.; Greig, W. R.; Thomson, J. A.;

Winning, J.; McGirr, E. M. (Royal Infirmary, Glasgow). Proc. Roy. Soc. Med., 62: 19-23 (Jan. 1969).

The effects of ^{131}I on patients with dysthyroid exophthalmos were determined. To minimize the total-body radiation dose, radioiodine thyroid ablation was carried out in a progressive fashion with an initial dose of up to 15 mCi ^{131}I to control thyrotoxicosis and further similar doses of ^{131}I at 2-month intervals thereafter until the 24-hr thyroid uptake was less than 30% of the dose. Ablation doses of up to 100 mCi ^{131}I were then given at 6-month intervals until a 5-day uptake of less than 0.2% of a 5-mCi dose of ^{131}I (preceded by thyrotrophin) was achieved. The results indicated that ^{131}I thyroid ablation is not in the short-term a useful therapy for the active severe eye changes of Grave's disease. A long period of time is likely to elapse before in any patient, the last thyroid cell "rests" are ultimately destroyed by radioiodine, during which time the visual status may deteriorate considerably. (BBB)

45847 NEVOCARCINOMA OF THE FOOT IN AN 80-YEAR-OLD FEMALE PATIENT. TRIAL TREATMENT WITH ^{35}S. Thiers, H.; Fayolle, J.; Deidier, C. Bull. Soc. Fr. Dermatol. Syphiligr., 75: 502-3 (1968). (In French).

A new treatment of malignant melanoma, using radiosulfur, is reported. The patient, 80-yr-old and with heart failure, could not be treated aggressively for a melanoma on the left toe, which later metastasized to the left inguinal lymphatics. Therefore, ^{35}S was given in the form of 14 doses of 10 mCi over a 10-month period. In spite of the initial treatments local dissemination of the tumor occurred and the inguinal lymph nodes continued to swell. Then after 9 doses the swelling decreased and local spread of the tumor ceased. The tumor could no longer be controlled several months later, and the inguinal nodes were removed. Liquid scintillation counting of the biopsied tissue revealed counts of 129,000 cpm, indicating marked uptake of ^{35}S by the tumor. Liver metastases developed, followed by death, but it is considered that ^{35}S had a transient, palliative effect on the melanoma. (BBB)

45848 IMMUNOLOGIC APPROACHES TO THE TREATMENT OF LEUKEMIA: PRELIMINARY RESULTS IN MAN. Mathe, G.; Schwarzenberg, L.; Amiel, J. L. (Institut Gustave Roussy, Villejuif, France). Nouv. Rev. Franc. Hematol., 7: 721-38 (Sept.-Oct. 1967). (In French).

Use of allogenic bone marrow grafts after whole-body irradiation to treat patients with leukemia is described. The principle behind the treatment is as follows. Leukemic subject A is irradiated over the entire body with the maximal tolerated dose, resulting in a considerable reduction, but not complete elimination, of leukemic cells. Subject A is then infused with bone marrow cells from normal donor B. The immunocompetent cells of B then populate A's bone marrow and react against A's blood cells, particularly his remaining leukemic cells. Presumably B's cells would not be as susceptible to the virus or other leukemogenic agent as A's cells. Experience in 24 attempts to carry out this plan in humans is described. An 800 R dose of irradiation was given in 2 sessions of 400 R each, 24 hr apart. Azathioprine (200 mg/m^2/day) was given 4 hr before irradiation, and bone marrow was injected 1 to 5 days after irradiation, followed by 400 mg/m^2 of prednisone. In 7 of the 24 attempts the bone marrow grafts failed to take. In the 17 successful grafts, death from secondary syndrome effects occurred in 14 cases and from infectious complications in 3. However, in several cases prolonged remissions from leukemia were obtained. Other trials of immunotherapy (active, passive, and adoptive) were performed in patients affected by leukemia or hematosarcomas. Nonspecific stimulation of immune defenses with BCG and vaccination with irradiated allogenic leukemic cells treated with formol were tried in patients with acute lymphoblastic leukemia in remission. The few patients treated are not numerous enough to permit a definitive interpretation of the results, but the results were suggestive of a potent effect of the active immunotherapy used in such cases. Some patients affected by chronic lymphocytic leukemia were treated with heterospecific antilymphoid serum. Transitory regressions of lymphocytosis were obtained. (BBB)

45849 EFFECTIVENESS OF RADIOTHERAPY IN EXPLORED INOPERABLE CARCINOMA OF THE LUNG. Guttmann, Ruth J. (Columbia Univ., New York). Bull. N. Y. Acad. Med., 45: 657-64 (July 1969).

The effects of high-dosage, high-voltage radiotherapy on lung cancer were studied, with emphasis on inducing fibrosis in the affected lung and sparing the unaffected one. The 103 patients were treated with irradiation after an exploratory thoractomy revealed an unresectable carcinoma of the lung, a total tumor dose of 5000 rad being delivered in 5 weeks by a 2-MeV x-ray unit through large opposing fields. No rotation or scanning irradiation was applied, as either of these methods delivers some radiation to the healthy opposite side. This additional irradiation is undesirable, as the preservation of the unimpaired function of the healthy opposite lung is essential for survival. Fibrotic changes in this lung would make the patient a respiratory cripple. The roentgenological appearance of a heavily irradiated lung indicated the expected and, in this situation, desired complete fibrosis. The immediate tolerance of this amount of radiation was excellent and there were no serious late side-effects. In none of the patients was there damage to the spinal cord or to any of the healthy surrounding organs. Symptomatic relief occurred in 75% of the patients and there was an increase in the life expectancy ranging from 1 to 13 yr. The 1-yr survival was 57.2%; the 2-yr survival 28.1%; 3-yr survival, 17.4%; 4-yr survival, 10.6%; 5-yr survival, 8.7%; and 10-yr survival, 6.8%. The average survival time of these patients was raised to 27 months, as compared to 10 weeks to 6 months reported for untreated patients. Microscopic evidence showed that with the high doses of radiation used, squamous-cell carcinomas of the lung were destroyed completely in some patients. (BBB)

45850 CCTV IS SUCCESSFULLY APPLIED IN COBALT TELETHERAPY. Can. Hosp., 46: 35 (Apr. 1969).

Use of a closed-circuit television (CCTV) system to allow medical personnel to supervise ^{60}Co radiotherapy in complete safety from radiation exposure is described. Because of the high level of radiation present in the therapy room, it is hazardous for staff members to be inside during treatments, yet the patients must be observed carefully and constantly during irradiation. To make this possible, a CCTV camera (with a remotely controlled pan and tilt unit) is mounted on a wall and aimed toward the ^{60}Co therapy machine. Stationed safely outside the room, a technician can operate the movement of the camera and select any of four lenses by remote control for viewing the patient on the monitor. The therapy machine projects a beam of light that corresponds precisely to the area of the body under irradiation. By dimming the other illumination inside the teletherapy room the operator may closely observe the placement of the beam while viewing the television screen. Several illustrations of the equipment and its operation are provided. (BBB)

45851 RECENT EXPERIENCES WITH A NEW APPROACH TO HARD-RAY THERAPY. Bally, E. (Kantonsspital, Lucerne, Switzerland). Medicamundi, 13: 89-93 (1969).

An x-ray tube was designed for hard-ray therapy (x-ray therapy using an energy range where water equivalent absorption occurs in bone). It was so designed that the required differential effect in depth could be obtained, not by reducing the x-ray tube tension, but by taking advantage of the square law by shortening the focus-skin distance to 6 cm as in classical short-distance irradiation. Six cases in which this new approach was successfully used are sited. (E.R.B.)

45852 EXTRACORPOREAL IRRADIATION IN THE TREATMENT OF ACUTE LEUKEMIA. Souhami, R. S.; Clifton, J. S.; Emery, E. W.; Godlee, J. N.; Prankerd, T. A. J.; Provan, J. L. (Univ. Coll. Hospital, London). Lancet, 2: 13-17 (July 5, 1969).

Effects of extracorporeal irradiation of the blood (ECI), used in the treatment of 5 patients with acute leukemia, are reported. Treatment was with a high dose administered over a short period of time. The irradiation was from a 4-bladed source containing 24 Ci of ^{90}Sr. The blades were arranged in pairs, with the active faces of each pair opposed, leaving space for the coil to pass between. The apparatus is designed as a fully protected, self-contained mobile unit. The dose administered depended on the number of turns in the coil; 1 to 6 turns giving doses of 2060 to 9860 Rad/day to 5 l of blood. ECI produced a fall in the total white blood cell (WBC) count, especially in the blast cells, but this effect was short-lived and was usually followed by a rise in the number of primitive cells to a level higher than before ECI. Two patients that had a reduction in the number of blast cells after the first course of irradiation showed no response to a second and similar dose. Another patient had no response to an initial dose of 10,000 Rad, but the WBC count fell rapidly after a second dose of 40,000 Rad. However, even this larger dose was only transient in its effect. The effect of ECI on the peripheral WBC count was no different whether the irradiation was undertaken as an initial treatment or as the last one in patients who had had intensive chemotherapy previously. No diminution in blast-cell infiltration of the marrow was observed after ECI, suggesting that neither of the 2 mechanisms, through which ECI might be effective, is obtained. Dissemination of the disease may possibly have been accelerated by the procedure; several patients showed striking and extensive leukemic infiltration of the skin about 1 week after irradiation was discontinued. (BBB)

45853 SOME OBSERVATIONS ON THE LOGISTICS OF RADIATION THERAPY FOR CANCER IN THE UNITED STATES.

Stein, Justin J. (Univ. of California, Los Angeles). CA - Cancer J. Clin., 19: 94-7(Mar.-Apr. 1969).

The types of radiotherapy equipment now in use in the United States and the advantages and disadvantages of each are outlined. The principal types of external radiation therapy are classified according to the kilovoltage power generated by the therapy equipment. They are: contact therapy (40 to 60 kV), superficial (80 to 140 kV), deep (orthovoltage or conventional) (180 to 400 kV), supervoltage (700 to 1000 kV), and megavoltage (above 1000 kV). The advantages of megavoltage therapy over conventional or orthovoltage therapy are as follows: increased depth dose; greater output; less pneumbra (with linear accelerators and betatrons); greater skin sparing; electron beam capability (except for radioisotope units) for treatment of cancer, for radiobiological studies, radiochemical experiments, and for bacteria sterilization using megarad doses; homogeneous fields; large field sizes are possible at long treatment distances; possibility of converting dosimetry data from x rays to electrons without much delay; relatively low maintenance cost; capacity to treat eight to 10 patients per hr; automatic dose control (preset control of dose delivered) can be added; scattered radiation is almost entirely in the forward direction; and energy absorption per gram in the bone is about the same as in the soft tissues. Some disadvantages in the use of conventional x-ray therapy as compared with megavoltage therapy are as follows: impracticable to treat large fields, such as the use of mantle technique for certain patients with Hodgkin's disease; greater systemic reactions because of scattered radiation to adjacent tissues; greater morbidity and possible delay in wound healing when used for preoperative radiation therapy; ineffective for bladder cancer because of severe bladder reaction and increased bladder contracture; marked skin reactions; possibly greater incidence of bone necrosis and of other complications; may be difficult to deliver adequate doses to certain types of cancer; and certain tumors surrounded by bone are better treated using megavoltage radiation therapy. Advantages of the 6-MeV linear accelerator over ^{60}Co teletherapy are: less pneumbra; greater output; no source to change; better depth dose; greater skin sparing (100% dose at 15 mm as compared to 55 mm for ^{60}Co); and electron beam capability for treatment of skin lesions. The numbers of megavoltage therapy machines currently in use in the United States are: 541 ^{60}Co, 33 linear accelerators, 23 betatrons, 13 2-MeV Van de Graaff generators, and six 1- and 2-MeV resonance generators, with a total of 616 machines in use. (BBB)

45854 LONG-PERIOD FRACTIONATION IN RADIOTHERAPY. Cohen, Lionel (General Hospital, Johannesburg). Brit. J. Radiol., 42: 551(July 1969).

An appeal for making available unpublished data on the response of skin fields, epidermoid cancers, or other commonly irradiated tissues or tumors, with treatment fractionated twice weekly or at intervals of one or more weeks was made. The data are to be used to distinguish between recovery effects due to intracellular repair processes (affected by the number of fractions) and from those of tissue regeneration (dependent on intervals between fractions). (C.O.)

45855 OVER 10-YEAR SURVIVAL IN IRRADIATED PATIENTS WITH HODGKIN'S DISEASE. Zielinski, Tadeusz; Jordan, Eugenia (Radiotherapy Clinic, Danzig). Nowotwory, 19: 153-60(Apr.-June 1969). (In Polish).

Out of 105 patients with Hodgkin's disease treated during 1953 to 1958 at the Department of Radiotherapy of School of Medicine in Gdańsk, 16 patients (15.2%) survived over 10 yrs. Among 31 patients with localized Hodgkin's disease, 13 patients survived 10 yrs (41.9%), including 9 (25.8%) without pathological symptoms. These observations indicate, that early stage of the disease and radical treatment with irradiation represent the basic factors assuring good prognoses in Hodgkin's disease. (auth)

45856 MALIGNANT DISEASE OF THE URINARY BLADDER. EXPERIENCE AT THE PETER MACCALLUM CLINIC, MELBOURNE, 1960-1965. Sandeman, T. (Peter MacCallum Clinic, Melbourne). Australas. Radiol., 13: 193-204(May 1969).

During the period 1960 through 1965, 262 cases (186 males, 76 females) of malignant bladder tumors were reviewed. Smoking influences the lowering of the age of onset, particularly in women. The lack of concomitant lung cancer is notable when 12 patients had other malignancies. The importance of pre-treatment staging and assessment of the histology is emphasized and a set of management guidelines is presented. Survival rate for the overall series show a five-year figure of 4/40 (10%) for unstaged cases and figures of 8/31 (23%), 6/35 (16%), 4/22 (18%), 2/20 (10%) and 2/76 (2.6%) for five stages of the Wallace staging system. The determinate figures at five years for radically treated, assessable cases are 7/15 (43%), 6/16 (35%), 4/12 (33%), 2/5 (40%) and 1/6 (17%) respectively. This suggests that early total cystectomy is indicated for uncontrollable, well differentiated mucosal tumors, while radiation alone is preferable for poorly or moderately differentiated tumors. Pure squamous or adenocarcinomas are radio-resistant and seldom operable, but cystectomy is the only treatment likely to be curative. A tendency to squamoid or adenocarcinomatous differentiation, however, is not a sign that radiotherapy will fail. Radiation under hyperbaric oxygenation holds some promise for improving the local clearance of tumor. (Australia)

45857 MODERN RADIOTHERAPY OF SARCOMA: IRRADIATION TECHNIQUE AND ITS RESULTS WITH RETICULAR BONE SARCOMAS. Sarrazin, D. (Gustav Roussy Inst., Villejuif, France). Zentralbl. Chir., 92: Suppl., 1672-85(1967). (In German).

The advantages of ^{60}Co irradiation over conventional 200-KV x ray in treatment of bone sarcomas were that skin reactions were decreased, the energy delivered was greater at greater tissue depths, exposure times were decreased, and the tumor doses could be more easily distributed. ^{60}Co also avoided overdosing of healthy bone, but the tumor cells in the poorly calcified zones received doses from the ^{60}Co that were low. In 85 young patients complications from the ^{60}Co treatments included irradiation castration during irradiation of the pelvis, lung inflammation after irradiation of the thoracic area, impairment of bone growth in long bones of most of the children when the irradiation dose exceeded 6000 to 7000 R, 3 skin reactions after irradiation of the spinal area, and 5 cases of sclerosis of the skin or edema. (BBB)

45858 STUDIES ON INTRA-ARTICULAR COLLOIDAL GOLD ^{198}Au IN RHEUMATOID ARTHRITIS. Yamamoto, Sumiki (Okayama Univ., Japan). Ryumachi, 8: No. 3, 14-28(July 1968). (In Japanese).

In the treatment of rheumatoid arthritis, local treatment is as important as general treatment to reduce the activity of this disease. Colloidal ^{198}Au was injected into knee joints in 27 patients with rheumatoid arthritis. All these cases had failed to respond to the injection of corticosteroids into the joints over a long period of time. Three months after the injection, follow-up examinations showed good result in 20%, fair 33%, and no improvement in 47%, and one year follow-up examinations showed good result in 10%, fair 33%, and no improvement in 57%. Most of colloidal gold ^{198}Au injected into the joints, remained in the joints and very little could be detected in the blood. When a dose of 1 mCi ^{198}Au, previously prepared in 20 ml saline, was injected and left one week, a radiation dose was the same as when 3,000 R was used. Arthroscopic observation was done several days after injection. When 3 to 5 mCi of ^{198}Au was injected, villi on the surface layer of the synovial membrane became flat and pale. There were some sections of the biopsy specimens of the synovial membrane obtained after injection of ^{198}Au that showed an increase of synovial fibrosis, exfoliation of lining cells, and atrophic appearance of lymph nodes or necrosis of germinal follicles. Microautoradiographic examination of the synovial membrane showed granules within the surface layer cells and fibroblasts in the deeper layers of the synovial membrane. Joint fluid was also examined by microautoradiography. There were irregular necrotic cells in the sediments of fluid that could not be stained by a single hematoxlin–eosin stain and showed many granules. These cells seemed to be the cells of synovial membrane that had become necrotic and fallen into the joint fluid. In order to see the effect of ^{198}Au on the cell in vitro, tissue culture was performed. Ascites cells of rats and rabbits were used for the purpose. These cells were stained by vital staining and observed by phase–contrast microscope. A different dose of ^{198}Au was poured over the different cell groups. Cell groups, over which a higher concentration of ^{198}Au was poured, showed distinct morphological changes which were mainly the formation of vacuoles and change of staining rate. (NSA of Japan)

Blast and Thermal Effects

Refer also to abstract 45768.

Radiation Effects on Animals

Refer also to abstracts 45605, 45643, 45648, 45651, 45658, 45708, 45712, and 45922.

45859 (ANL-7535) BIOLOGICAL AND MEDICAL RESEARCH DIVISION ANNUAL REPORT, 1968. (Argonne National Lab., Ill.). Dec. 1968. Contract W-31-109-eng-38. 338p. Dep. CFSTI.

Separate abstracts were prepared for 57 papers that were within the scope of NSA. In addition, another 96 papers were included in

the 1968 annual report, including papers in microbial genetics, developmental biology, mechanisms of carcinogenesis, radiation protection, cellular and somatic effects, theoretical biology, characterization of the Argonne National Laboratory beagle, laboratory animal medicine, biophysics, cellular biochemistry, enzymology, isotope studies, cellular fine structure, plant radiobiology, and growth and development of plants in compensated gravitational, magnetic, and electrical fields. A list of staff publications and an author index is included. (C.O.)

For abstracts of individual papers see: 45220, 45439, 45440, 45604–45608, 45624, 45643, 45673, 45674, 45689–45696, 45721, 45722, 45729–45734, 45784, 45785, 45794, 45835, 45860–45862, 45876–45879, 45885–45898, 45946, 45967, 45968, and 47036.

45860 (ANL-7535, pp 89-92) THE ULTRASTRUCTURAL LOCALIZATION OF ACID PHOSPHATASE IN THE AREA PELLUCIDA OF THE CHICK EMBRYO: EFFECT OF X RADIATION. Stearner, S. Phyllis; Sanderson, Margaret H. (Argonne National Lab., Ill.).

In chick embryos sacrificed within 90 min after lethal x irradiation, acid phosphatase activity in the structures of the Golgi complex appears to be increased. No information about changes in enzyme localization at longer times after exposure is available. A later shift to multivesicular bodies, followed by a decrease in detectable enzyme activity in the cell, has been suggested from studies in the irradiated mouse. It is believed that the increased amount of reaction product visualized in the Golgi complex at 90 min after lethal irradiation may represent activation of previously inactive or bound enzymes. The increased plasma acid phosphatase activity observed after 3 to 5 hr in the lethally irradiated chick may reflect release of activated enzyme from the cells. (auth)

45861 (ANL-7535, pp 196-7) PROTECTION BY CYSTEAMINE AGAINST X-RAY DAMAGE DURING THE CELL CYCLE OF CHINESE HAMSTER CELLS. Sinclair, Warren K. (Argonne National Lab., Ill.).

Using 75 mM cysteamine (present during irradiation only), the survival of synchronous populations of Chinese hamster cells after irradiation with x rays at doses up to 1200 R was studied. The Dose Modifying Factor (DMF) for cysteamine showed a least value in late S, a greater value in G_1, and a greatest value in mitosis. In studies of the pre- and post-irradiation effects of cysteamine, it was found that 30 min exposure prior to irradiation resulted in no protection or small sensitization when added to G_1 or S cells. Cysteamine added shortly after irradiation protected G_1 cells slightly, but reduced the survival of S cells slightly. It was concluded that the results emphasize the differential effects of cysteamine on radiation response at different stages of the cell cycle and that the differential protective action of cysteamine is peculiar to the presence of sulfhydryl groups. (C.O.)

45862 (ANL-7535, pp 199-201) SENSITIVITY OF SYNCHRONIZED CHINESE HAMSTER CELLS TO ULTRAVIOLET LIGHT. Han, Antun; Sinclair, Warren K. (Argonne National Lab., Ill.).

A population of cultured, synchronized Chinese hamster cells was uv irradiated with a germicidal lamp of predominant wavelength 253.7 nm at 270 erg/mm^2. Survival curves were obtained for mitotic, G_1, S, and G_2 cells. Results showed that mitotic cells are the most resistant fraction of the population and S cells were the most sensitive. The effects of adding the cellular process inhibitors, cycloheximide (CH), hydroxyurea (HU), and thymidine (TdR) prior to irradiation were also studied to investigate the relation between age response and different biochemical processes. CH reduced the rate of DNA protein and synthesis to a negligible value within one hr. Inhibitors of DNA and protein synthesis added to G_1 cells resulted in less resistance at the G_2 stage; that is, the minimum in survival observed in the S phase was not followed by an increase in survival, as in control populations. Inhibition of DNA synthesis by excess TdR in the middle of S did not prevent cells from acquiring the resistance normally seen in G_2. Addition of CH in the middle of the S phase prevented the G_2 rise in survival, implying that proteins may be, at least in part, responsible for the development of the resistance in G_2. (C.O.)

45863 PROLIFERATION KINETICS OF X-IRRADIATED MOUSE L CELLS STUDIED WITH TIME-LAPSE PHOTOGRAPHY. II. Thompson, L. H.; Suit, H. D. (Univ. of Texas, Houston, Texas Medical Centre, Houston). Int. J. Radiat. Biol., 15: 347-62(1969).

Proliferation kinetics of x-irradiated mouse L-P59 fibroblasts were studied by constructing cell pedigrees from photographic records. Parameters of proliferation showed marked age dependence; early G_1 cells were most resistant and late S–G_2 cells were most sensitive in terms of reduction in probability of division, increase in generation time, and induction of abnormal mitotic figures (multipolar and incomplete mitoses). Division probabilities were higher at first division than at subsequent divisions, and cell death in some pedigrees was absent until the fourth generation or later. Prolongation in generation time occurred during several post-irradiation divisions, most noticeably in abortive clones. The idea that chromosome damage may not be the major cause of cell killing is suggested by the observations that frequency of first division lethal sectoring showed no age dependence; multipolar mitosis appeared to account for a significant proportion of non-surviving clones at low doses. (auth)

45864 RECOVERY OF CULTURED CELLS AFTER FAST NEUTRON IRRADIATION. Broerse, J. J.; Barendsen, G. W. (Nederlandse Organisatie voor Toegepast Natuurwetenschappelijk Onderzoek, Rijswijk). Int. J. Radiat. Biol., 15: 335-9(1969).

In view of its importance for radiotherapy, the effects of dose fractionation were investigated for 15 MeV neutrons and x rays, using the reproductive capacity of cultured human cells as a criterion for survival. In the split-dose experiments either the magnitude of the second dose or the time interval between the two fractions was varied. After neutron irradiation a significant recovery effect has been observed, which is approximately a factor of two smaller than after x-irradiation. (auth)

45865 EFFECT OF RADIATION ON RAT ERYTHROCYTES. Clarke, J. A.; Proukakis, C.; Salsbury, A. J. (St. Bartholomew's Medical Coll. and Hospital, London). Int. J. Radiat. Biol., 15: 389-92(1969).

Rats were exposed to 15 MeV x rays from a linear accelerator Whole-body doses of 400, 1000, 2000, and 3000 rads, respectively. At various times after exposure, the red cells were examined with a scanning electron microscope. Radiation damage, in the form of protuberances, became significant by the ninth day after irradiation. After doses of 1000 rads or more, damage was evident within the first day. In vitro exposure required much higher doses; therefore, radiation injury to blood vessels must be a contributing factor to the enhanced radiosensitivity of red cells in vivo. (H B.G.)

45866 A LUNG-COLONY ASSAY TO DETERMINE THE RADIOSENSITIVITY OF THE CELLS OF A SOLID TUMOUR. Hill, R. P.; Bush, R. S. (Ontario Cancer Inst., Toronto). Int. J. Radiat. Biol., 15: 435-44(1969).

An assay system is described in which a number of single tumor cells are injected intravenously into recipient mice and grow in the lungs of these mice to give macroscopic tumor nodules in 16 to 20 days. The relationship between the number of tumor nodules observed and the number of cells injected has been found to be linear up to a mean of 50 colonies/lung for both non-irradiated and irradiated cells, and the inter-experiment consistency has been shown to be good. The number of tumor nodules observed has been found to be affected by the simultaneous injection of a large number of heavily-irradiated cells, provided they are injected intravenously. An aerobic radiation survival-curve has been established and agrees very well with one obtained for the same tumor using the end-point dilution assay method. The assay has the advantage that the time required for completion is short, compared with that required for end-point dilution assays. (auth)

45867 MODIFICATION OF RADIATION RESPONSE THROUGH GLUCOSE-CONTROLLED RESPIRATION. Biaglow, John E.; Lavik, Paul S.; Ferencz, Nicholas Jr. (Case Western Reserve Univ., Cleveland). Contract No. W-31-109-Eng-78. Radiat. Res., 39: 623-33(Sept. 1969). (COO-78-182).

The radiation response of cultured Chinese Hamster ovary cells was found to be increased during a period of decreased respiratory activity caused by the addition of glucose (Crabtree effect). This increased sensitivity was demonstrated as both a decreased rate of growth in suspension culture and a reduction in colony-forming ability, as compared to cells irradiated in normal growth medium. These results may be accounted for by increase in intracellular oxygen tension and decreases in NADH plus NADPH during radiation. (auth)

45868 RADIOSENSITIVE STRUCTURE OF METAPHASE AND INTERPHASE HAMSTER CELLS AS STUDIED BY LOW-VOLTAGE ELECTRON BEAM IRRADIATION. Zermeno, Alfonso; Cole, Arthur (Univ. of Texas, Houston). Radiat. Res., 39: 669-84(Sept. 1969).

Electron beams of 3- to 50-keV energies were used to irradiate monolayers of hydrated metaphase and interphase hamster cells from in vitro cultures. Survival, defined as clone forming ability, was measured for a number of dose points and the D_{37} doses determined. Plots of D_{37} vs. beam voltage exhibited characteristic shapes which, when compared with analytically simulated dependencies, implied that the major radiosensitive structure is a thin peripheral shell close to the nuclear membrane in the interphase cells and a considerably thicker peripheral shell in metaphase cells. In addition the metaphase cells exhibited a fourfold

greater sensitivity and a negligible shoulder on the survival curves. (auth)

45869 IRRADIATION OF SYNCHRONIZED CELL CULTURES. EFFECTS ON MITOTIC DELAY AND NUCLEIC ACID SYNTHESIS. Firket, H. (Univ., Liege). Biophysik, 6: 34-8(1969).

When HeLa cells are synchronized by the double thymidine block method, it is shown that the mitotic delay produced by 450 R x rays is longer when cells are irradiated in G_2 than in G_1 but longer still when they are irradiated in the early part of S. DNA synthesis, measured by ^{3}H-thymidine incorporation, is not reduced considerably (±25%) and only for a few hours when 600 R are given at this time. A more pronounced inhibition occurs when irradiation is given later in S. There is also no decrease in incorporation of ^{3}H-orotic acid in RNA when the cells are irradiated in S or in G_2. These results are discussed and it is concluded that the long mitotic delays cannot be due to a modification of nucleic acids metabolism. (auth)

45870 EFFECTS OF X IRRADIATION ON MAMMALIAN OOCYTES IN ORGAN CULTURE. Baker, T. G.; Neal, P. (Univ. of Birmingham, Eng.). Biophysik, 6: 39-45(1969).

A technique for maintaining mammalian ovaries in organ culture is described. Ovaries of rats, mice, monkeys and humans have been maintained in a histologically normal condition for up to 20 days in culture, during which many were x irradiated. The doses of x rays required to destroy all the primordial oocytes in organ cultures are similar to those reported for in vivo studies. The human fetal ovary is resistant to x irradiation. Some oocytes survive for 7 days following exposure to 4000 R in organ culture. The radiation sensitivity of the human ovary is discussed; it would appear that it is among the most resistant to oocyte-killing known. (auth)

45871 EFFECTS OF MICROIRRADIATION WITH UV BEAM ON DIFFERENT PARTS OF THE CELL. I. ELECTRON MICROSCOPY STUDY ON TRANSVERSE AND SAGITTAL SERIAL SECTIONS. Moreno, Giuliana; Vinzens, Francoise (Hopital de Bicetre, France). Exp. Cell Res., 56: 75-83(July 1969). (In French).

Electron microscopic examination of transverse and sagittal serial sections of a locally irradiated cell by a beam of uv light (2750 or 2313 Å) permitted the study of: localization of the lesions: structure of the lesions and their correlation with morphologic alterations observed by light microscopy previously reported in the literature. The lesions had a transverse diameter of the same magnitude as the diameter of the irradiation beam, but in relation to the distribution of energy in the irradiation beam, damage also occurred on either side of the focal plane. Total irradiation of the nucleus caused the formation of chromatin clumps scattered throughout the nucleus. This alteration was also observed after partial nuclear and/or nucleolar irradiation. Moreover, dispersion of the nuclear or perinucleolar chromatin in the irradiated area was noted. Nucleolar irradiation produced a dispersion of nucleolar constituents. These nuclear lesions are discussed in relation with paling phenomenon observed with light microscopy. Cytoplasmic irradiation provoked in the irradiated area swelling of mitochondria, dilatation of the endoplasmic reticulum, and the formation of vacuoles. (auth)

45872 NON-PROTEIN SULFHYDRYL CONTENT AND CELL-CYCLE DYNAMICS OF EHRLICH ASCITES TUMOR. Harris, J. W.; Patt, H. M. (Univ. of California Medical Center, San Francisco). Exp. Cell Res., 56: 134-41(July 1969).

The non-protein sulfhydryl (NPSH) content of Ehrlich ascites tumor cells was measured in relation to cytokinetic parameters of tumor growth. Thymidine labeling index, NPSH, mitotic index, and protein were assayed under a variety of experimental conditions, both in the hours following transplantation and during subsequent daily growth of the tumor. In some experiments, x radiation was used to block cells in G2. Cellular NPSH declined during progressive tumor growth. This decrease appears to reflect the increasing proportion of non-proliferating (G0 or G1-like) cells or the decreasing proportion of proliferating cells in the tumor. When cells from 7-day tumors were transplanted into fresh mice, G0 cells moved back into the cycle at S and the mean cellular NPSH content more than doubled within 9 hr. When large inocula were used, the post-transplantation increases in the proportion of cells synthesizing DNA and in the mean NPSH level were greatly reduced. These results suggest that G0 cells contain less NPSH than do proliferating cells. There was no evidence that proliferating cells contain more NPSH in late G2 or in mitosis than in any other phase of the cell cycle. The rise in cellular NPSH concentration following transplantation was not affected by prior x radiation (1250 R), indicating that movement of G0 cells back into the cell cycle is not particularly radiosensitive. (auth)

45873 THE ULTRASTRUCTURE OF MONONUCLEAR PHAGOCYTES FOLLOWING INTRAPERITONEAL ADMINISTRATION OF $^{239}PuO_2$ PARTICLES. Sanders, C. L.; Adee, R. R. (Battelle Memorial Inst., Richland, Wash.). RES J. Reticuloendothel. Soc., 6: 1-23(Feb. 1969).

Female Sprague–Dawley rats were given intraperitoneal injections of 1.4 μCi $^{239}PuO_2$ particles suspended in 2 ml of saline. Other rats were given intraperitoneal injections of saline only, ThO_2, or latex particles. The animals were sacrificed at 2, 4, and 6 hr and at 1 and 7 days after injection, at which time peritoneal cells were prepared for electron microscopy. Numerous particles were found to be localized within cytoplasmic vacuoles of phagocytes. The subcellular localization of Pu particles was demonstrated by electron microscopic autoradiography. Only minimal alterations were found during the 6-hr period after Pu injections. Significant alterations found at 1 and 7 days included a marked increase in phagocyte size, an increased number of pseudopodial projections, necrosis of peritoneal cells, and their subsequent engulfment by phagocytes. Pu and Th particles were found lining the interior surface of lysosomes at 7 days. No significant degeneration of peritoneal phagocytes was observed at 7 days after Th or latex injections. Phagocytes exhibited a relative radioresistance to α irradiation from Pu particles. (BBB)

45874 EFFECTS OF PULSES OF RADIATION ON THE SURVIVAL OF MAMMALIAN CELLS. Nias, A. H. W.; Swallow, A. J.; Keene, J. P.; Hodgson, B. W. (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Brit. J. Radiol., 42: 553(July 1969).

HeLa cells or Chinese hamster cells were irradiated in suspension with 8 to 14 MeV electrons at various distances; survival of clone-forming ability was determined. Dosimetry was made by the modified Fricke dosimeter. With aerobic suspensions of HeLa cells, pulses of 5 μsec duration gave the same shape survival curve as the 1 μsec pulses; Chinese hamster cells responded in a similar manner. No break occurred in the survival curve of aerobic cells; in suspensions equilibrated with 0.35% oxygen, survival curves showed a break. Cells irradiated under N_2 were less sensitive. No indication of significant differences between the effects of single pulses of radiation and x rays delivered at conventional doses was observed. (C.O.)

45875 DAMAGE AND RECOVERY OF CULTURED CELLS AFTER X-RAY TREATMENT. Schaefer, Dieter (Kernforschungsanlage, Juelich, Ger.). Protoplasma, 67: 237-47(1969). (In German).

Ultrastructural studies were made of embryonic chicken heart cells cultivated in vitro and x-irradiated by a sublethal dose of 2400 R or with lethal doses (>3000 R). Phase-contrast microscopic examination was made of the surviving myoblasts and electron microscopy was carried out on uranyl acetate-phosphomolybdic acid stained cells that were fixed ½ to 24 hr post-irradiation. Soon after irradiation vacuoles were observed by phase-contrast microscopy, which after examination by electron microscopy proved to be electron-lucent dilatations of various origin. In addition to enlargements of perinuclear space, endoplasmic reticulum, and Golgi apparatus, it was possible to observe depleted mitochondria or parts of them, as well as ribosome-free areas in the groundplasm. The mitochondria were destroyed to a great extent and substituted by new ones. However, all such damage was removed within 10 hr. (BBB)

Invertebrates

Refer also to abstracts 45667, 45670, and 45706.

45876 (ANL–7535, pp 69-73) RECOVERY OF SUPRALETHALLY X-IRRADIATED AMOEBAE AFTER THE INJECTION OF UNIRRADIATED CYTOPLASM. Daniels, Edward W. (Argonne National Lab., Ill.).

Hyalin (optically clear) cytoplasm with abundant ribosomes although few, if any, ribosome clusters and no nuclei, has the capacity to restore supralethally x-irradiated amoebas. After therapy, via microsurgical transfer of unirradiated cytoplasm, the supralethally irradiated amoebas survive and reproduce normally for an indefinite period. The active therapeutic ingredients appear to be either ribosomes, or the optically-clear hyalin cytoplasm in which they are suspended. Donor mitochondria are probably not essential to radiorestoration. (auth)

45877 (ANL–7535, pp 109-12) RADIATION EXPOSURE OF FLOUR BEETLES. I. THE LETHAL EFFECTS OF NEUTRON OR GAMMA IRRADIATION ON TRIBOLIUM CASTANEUM. Yang, Tracy Chui-Hsu (Argonne National Lab., Ill.).

A shoulder was found in the dose-response curve of neutron-irradiated Tribolium. Results obtained suggest that neutron ir-

radiation has higher latent lethal effect on T. castaneum than has gamma irradiation. Although no significant change in RBE value was observed between 20th day and the 50th day post-irradiation, the RBE, at the 60th day post-irradiation, increased slightly. (auth)

45878 (ANL-7535, pp 112-13) RADIATION EXPOSURE OF FLOUR BEETLES. II. RADIOSENSITIVITY OF TRIBOLIUM CASTANEUM ADULTS IRRADIATED AT THE LARVAL STAGE. Yang, Tracy Chui-Hsu (Argonne National Lab., Ill.).

The decreased $LD_{50/30}$ for T. castaneum adults, irradiated at the larval stage with sublethal doses, was approximately equal to the amount of residual injury determined by the split-dose technique on adults. More data are needed to answer the question of whether the conditioning dose has changed the radiosensitivity of adults or simply damaged the recovery mechanism of adults. (auth)

45879 (ANL-7535, pp 114-16) RADIATION EXPOSURE OF FLOUR BEETLES. III. THE EFFECT OF PROTRACTED GAMMA IRRADIATION ON THE MEDIAN SURVIVAL TIME OF FLOUR BEETLES (TRIBOLIUM) DURING DEVELOPMENTAL STAGES. Yang, Tracy Chui-Hsu (Argonne National Lab., Ill.).

The same dose of ^{60}Co gamma radiation caused different amounts of median life-span shortening, in days, depending on the developmental stage (egg, larval, pupa, or adult) receiving the exposure. The radiation given in an early developmental stage usually enhances the effect of radiation given at a later development stage on the median life-span shortening of adults. These results, however, suggest that the median survival-time shortening of adults, in days, is additive for all developmental stages. (auth)

45880 TEMPERATURE EFFECT ON PROTECTIVE ACTION BY CYSTEAMINE AGAINST X-RAYS IN THE FISH, ORYZIAS LATIPES. Egami, Nobuo (National Inst. of Radiological Sciences, Chiba, Japan). Int. J. Radiat. Biol., 15: 393-4(1969).

Following cysteamine treatment, fish (Oryzias latipes) were kept in water of various temperatures and were exposed to 2500 r of 200 Kv x-rays. The experimental data indicate a protective action by cysteamine against x-rays, and the action is not modified by the fish body-temperature during treatment. From this it seems unlikely that any temperature-dependent metabolic processes play an important role in the radioprotective action of cysteamine. (H.B.G.)

45881 VARIATION OF RADIOSENSITIVITY IN SYNCHRONIZED CELL POPULATIONS OF SILKWORM EMBRYOS EXPOSED TO X-RAYS. Murakami, Akio (Bowling Green State Univ., Ohio. National Inst. of Genetics, Misima, Japan); Teulade, Pierre. Int. J. Radiat. Biol., 15: 315-22(1969).

To clarify the relationship between radiosensitivity and cell-cycle in the early cleavage stages of the silkworm, the dose–response curves of different cell phases were analyzed. Curves for the sensitive phase have a shoulder that is narrower than the curves for the resistant phase. This is the same regardless of developmental stages of embryos and change in the number of nuclei (or target). It implies that an explanation of this different shape of dose–response curve cannot be made within the framework of the target theory in the ordinary sense. (auth)

45882 RADIOSENSITIVITY STUDIES OF X-IRRADIATED TRIBOLIUM CASTANEUM LARVAE. Yang, Tracy C. H.; Ducoff, Howard S. (Univ. of Illinois, Urbana). Radiat. Res., 39: 643-54(Sept. 1969).

The general pattern of the time course of survival of Tribolium castaneum larvae, irradiated at different ages (from 2 to 17 days old), was similar when exposures from 2.0 to 5.0 kR were used. Mortality during the larval stage was rare, but mortality between pupation and a time shortly after eclosion was frequent. Young larvae were less radiosensitive than old larvae. The $LD_{50(60)}$ for 2-, 7-, 12-, and 17-day-old larvae, maintained at 30°C, were 4.95, 4.30, 3.20, and 3.20 kR, respectively, at an exposure rate 230 R/minute. When the exposure rate changed from 230 to 1250 R/minute, mortality was slightly increased. The $LD_{50(100)}$ of 14-day-old larvae, kept at 22°C postirradiation, was similar to the $LD_{50(60)}$ of 14-day-old larvae kept at 30°C. Larvae kept at 15°C for 12 hours before and after irradiation and for 24 hours postirradiation exhibited no significant change of response, as compared to untreated larvae. Exposure of larvae to 15°C for 24 hours prior to irradiation, however, showed a slight increase of radiosensitivity. (auth)

45883 LETHAL EFFECTS OF GAMMA RADIATION ON EGGS AND LARVAE OF THE BAGWORM, THYRIDOPTERYX EPHEMERAEFORMIS. Reichle, D. E. (Oak Ridge National Lab., Tenn.). Ann. Entomol. Soc. Amer., 62: 1113-17(Sept. 1969).

Responses of insect populations in irradiated ecosystems are important factors involved in the functional and structural stabilization of the systems. Eggs and larvae of Thyridopteryx ephemeraeformis (Lepidoptera: Psychidae) were γ irradiated in a ^{60}Co source to establish a profile of radiation sensitivity for different ages and stages of development. One-day-postdiapause eggs were the most radiosensitive life stage examined; the LD_{50} progressively increased during embryonic development to 14,790 rad for 8-day eggs. Immediately preceding hatching (12 days), eggs were also quite radiosensitive (LD_{50-20} days = 1905 rad). Larvae showed no significant response with respect to age or size; the mean LD_{50-20} for size classes ranging from 0.12 to 90.16 mg dry weight was 10,633 rad. Lower doses of ionizing radiation (3200 rad) showed a significant 12% increase in percent hatching of 8-day-old eggs. Radiation doses to eggs at a level one-half that required to produce significant larval mortality were found to interfere with case-building behavior of young larvae. (auth)

Vertebrates

Refer also to abstracts 45634, 45644, 45645, 45657, 45659, 45660, 45666, 45671, 45673, 45675, 45678, 45679, 45693, 45698, 45709, 45710, 45715, 45784–45789, 45792, 45826, 45860, 45870, and 45937.

45884 (AD-690130) RADIATION MORTALITY OF RODENTS UNDER HYPOBARIC-HYPOXIC CONDITIONS. Final Report, June-October 1968. Melville, George S. Jr.; Stork, Emmett J.; Gass, Arthur E. Jr.; Rusk, Perry D.; Rasmon, Jimmie (School of Aerospace Medicine, Brooks AFB, Tex.). Apr. 1969. 21p. (SAM-TR-69-18). CFSTI.

This study was conducted to establish whether reduced oxygen concentration (hypoxia) and reduced atmospheric pressure (hypobarism) significantly change the radiosensitivity of rodents. Approximately 1,800 male Swiss-Webster mice, committed in groups of 50, and 56 male Sprague-Dawley rats were γ-irradiated at low dose rates in an altitude chamber. Experimental groups of hypoxic and hypobaric mice received total doses of 900 to 2,100 R ^{60}Co γ rays. Survival in all experimental groups was negligible; in one instance less than that of corresponding controls. In most experimental groups, however, the hypoxic-hypobaric groups achieved a longer mean survival time than did corresponding controls. At 1,300 R, the control group achieved a mean survival time of 7.3 days. Three groups similarly irradiated but hypoxic and hypobaric at 22,500 ft. recorded mean survival times of 9.7 days, 9.9 days, and 9.7 days, respectively. Additionally, three groups similarly irradiated but hypoxic and hypobaric at 15,000 ft. achieved mean survival times of 10.2 days, 12.7 days, and 12.4 days, respectively. The LD50/30 for normal mice irradiated as controls in the apparatus at ambient pressure and oxygen concentration was calculated to be 850 plus or minus 72 R. By assuming the validity of the hypothesis that hypoxia is radioprotective, simultaneous hypobarism appears to nullify, at least partially, this radioprotective effect. (TAB)

45885 (ANL-7535, pp 28-31) MECHANISMS OF CARCINOGENESIS. Brues, Austin M.; Auerbach, Harry; DeRoche, Georgia M.; Grube, Donald D. (Argonne National Lab., Ill.).

All types of subcutaneously implanted, solid discs that have been tested have yielded sarcomas. This response virtually disappears as the porosity of Millipore filter materials is increased in the range between 0.1 μ and 1.0 μ; however, discs with large holes spaced 1 mm or so apart are effective in producing tumors. Mylar-laminated disks of $^{90}Sr-^{90}Y$ (0.5 to 5 μCi) produce larger numbers of tumors after a shorter interval. At 2 to 2½ years, completely negative results indicate that beagle dogs are, at least, relatively resistant to the action of either radioactive or cold implants. We have confirmed our previous finding that 400 R x irradiation to rats during the latent period does not increase the yield of sarcomas from cold implants. The effect of castration on the fate and carcinogenicity of subcutaneously injected particulate ^{239}Pu and the possible promoting effect of phorbol esters on external beta ray carcinogenesis are under investigation. (auth)

45886 (ANL-7535, pp 35-7) CELLULAR PROLIFERATION AND CARCINOGENESIS. Reiskin, Allan B.; Sallese, Anthony R. (Argonne National Lab., Ill.).

An in vivo system, the epithelial lining of the hamster cheek pouch has been studied from two different aspects. First, proliferation kinetics have been measured as a function of three different physiological responses (aging, diurnal rhythms, and transplantation) and second, the effects of chemicals and irradiation as carcinogens on proliferative behavior were studied. Acute doses of 2,500 to 10,000 rads from a $^{90}Sr-^{90}Y$ medical applicator were directed at the cheek pouches of 22 hamsters. Minimal tissue changes were grossly visible, and only within the three weeks postirradiation. Histologic and autoradiographic studies showed a

response in the epithelial lining, but showed little infiltration by inflammatory cells. No tumors were found up to three months postirradiation. (C.O.)

45887 (ANL–7535, pp 74–6) SURVIVAL OF MICE UNDER DAILY GAMMA IRRADIATION: PROGRESS REPORT FOR INCIDENCE OF SOME TUMORS. Grahn, Douglas; Sacher, George A.; Fry, R. J. Michael; Rust, John M.; Cooke, Eugenia M.; Staffeldt, Everett (Argonne National Lab., Ill.).

Mice of four different strains were exposed to gamma radiation at doses of 0.3 to 56 R daily for the duration of their lives to study radiation effects on life span on the incidence of tumors in four selected tissues (liver, lungs, ovaries and reticular tissues). A characteristic high incidence of tumors of the thymus early in life and at high dose rates was shown. A rise in reticular tumors (including leukemias) was also noted in the 1.3 R/day group. These often occurred later in life. The significance of these findings is discussed briefly. (C.O.)

45888 (ANL–7535, pp 83–4) ACUTE RADIATION MORTALITY IN THE ROOSTER: EFFECT OF DOSE PROTRACTION. Stearner, S. Phyllis; Tyler, Sylvanus A. (Argonne National Lab., Ill.).

Reduction in ^{60}Co γ dose effectiveness with increase in exposure time through 360 min was approximately linear. There was only a small further decrease in the 480-min exposure groups. When exposures were protracted over longer periods, radiation sensitivity increased and, with 1440-min exposures, was similar to the sensitivity observed in the 90-min groups. With exposure periods through 480 min, the time effect was comparable to that reported previously in the 3-day chick, both in linear kinetics and in amount of dose reduction. The increased radiosensitivity observed when protraction was over longer periods, however, is not consistent with this model. From comparisons of mortality data from the adult rooster, the newly-hatched chick, and the chick embryo, it is evident that our kinetic model of radiation injury accumulation must be reevaluated. The effect of dose protraction in the rooster suggests that a radiation-induced resistance may have a significant role in the increased tolerance especially evident with 360- and 480-min exposures. An acquired resistance has been demonstrated for 3- to 30-day mortality after split exposures in the 3-day chick, and a similar response is suggested from split dose studies now in progress in the rooster. (auth)

45889 (ANL–7535, pp 84–9) EFFECT OF EXPOSURE TIME ON EARLY RADIATION INJURY TO THE MICROCIRCULATION IN THE CHICK EMBRYO. Stearner, S. Phyllis; Christian, Emily J. B. (Argonne National Lab., Ill.).

Early effects of 1100 R x irradiation, delivered in a period of 12 min, on the microcirculation of the chick embryo was previously shown to produce vascular lesions leading to the collapse of small blood vessels, as well as the adhesion of circulating cells to the endothelial surface. This study demonstrated the effect of dose protraction on radiation damage to the microcirculation. Degenerative effects were reduced when exposure time was extended from 12 min to 240 min. Damage appeared to be localized in individual endothelial and perivascular cells, rather than generalized throughout the vascular system. The effect of protraction of the exposure on vascular degeneration is comparable to that previously reported for the early radiation lethality in the chicken and the chick embryo. (auth)

45890 (ANL–7535, pp 96–7) IONIZING RADIATION AND BEHAVIOR. Morris, Dale D.; Pagels, Jeanne A.; Dipert, Merlin H. (Argonne National Lab., Ill.).

A study of the development of temporal discrimination during free-operant avoidance by C_3H mice has been completed. Each animal was placed in a conditioning chamber with an electric shock programmed every 3 sec. Each lever press delayed the next shock for 20 seconds. The animals learned to press the lever with a response-response interval of less than 20 sec to avoid the shock. The mice were given daily sessions until their response rate became stable. The duration of the inter-response (IRT) was measured, and a frequency distribution of the IRT's, measured in two second class intervals, was constructed for each session. A second frequency distribution was constructed that yields the probability of occurrence of IRT_{n+1} given IRT_n. Changes have been made in the computer programming to permit greater ease and speed in this type of experiment. A schematic diagram is given of the new methods. (C.O.)

45891 (ANL–7535, pp 151–3) THE RESPONSE OF BEAGLE DOGS TO PROTRACTED EXPOSURE TO ^{60}Co γ RAYS AT 5 TO 35 R/DAY. Norris, William P. (Argonne National Lab., Ill.).

Beagle dogs were irradiated at doses of 5 to 35 R per day from a 9 Ci ^{60}Co source (doses varied with distance from source). Five of the eight dogs in the 17 R/day group died at 85 to 173 days. The remaining three dogs seem to be achieving a steady state in total white blood cells and in platelets. The steady-state hematological picture in the 5 to 10 R groups has not been shown, however. Thrombocytopenia occurred, but the hemorrhage that might be expected to happen, did not occur. Terminal septicemia was demonstrated in most of the animals that died. (C.O.)

45892 (ANL–7535, pp 156–7) THE RESPONSE OF BEAGLE DOGS TO PROTRACTED EXPOSURE TO ^{60}Co γ RAYS AT 5 TO 35 R/DAY. II. SURVIVAL AND CLINICAL OBSERVATIONS. Norris, William P.; Poole, Calvin M. (Argonne National Lab., Ill.).

The clinical responses of 64 dogs to continuous γ radiation at doses of 5 to 35 R/day were observed. Survival time at 35 R/day ranged from 37 to 68 days and it was estimated that at 40-day exposure at that rate would represent a 50% acutely lethal dose. At 17 R/day, 5 of 8 dogs died at 85 to 173 days. No mortality in dogs exposed to 5 or 10 R/day has been observed. Terminal symptomatology (including petechiation of the oral mucosa, loss of appetite, elevated rectal temperature, depression, diffuse skin hemorrhages, abnormal feces with blood, and dehydration) was similar in all the decedents whether they received 17 or 35 R/day. Severe thrombocytopenia was found in all dogs at the three highest exposure levels. It was concluded that the terminal symptoms observed in most dogs were the result of septicemia, with no obvious relevance to thrombocytopenia, nor to the pattern of radiation exposure which produces the leukopenia which allows the invasion of pathogenic organisms. (C.O.)

45893 (ANL–7535, pp 158–9) THE RESPONSE OF BEAGLE DOGS TO PROTRACTED EXPOSURE TO ^{60}Co γ RAYS AT 5 TO 35 R/DAY. III. HEMATOLOGY. Rehfeld, Carl E.; Doyle, Donald E.; Chladek, Dorothy L.; Pearson, Donald L.; Polk, Patrick, H. (Argonne National Lab., Ill.).

Radiation-induced leukopenia, anemia, and thrombocytopenia occur in a graduated or dose-responsive manner when dogs are exposed continuously to ^{60}Co gamma rays at dose rates of 35, 17, 10, and 5 R/day. After 215 days, there are indications that leukocyte and thrombocyte numbers in venous blood may stabilize at about a 50% level among dogs receiving exposures of 5 R/day, while the erythrocytes at this exposure remain at essentially a normal level. There is no reliable indication that such a stabilization occurs in dogs receiving the other three exposures. (auth)

45894 (ANL–7535, pp 159–60) THE RESPONSE OF BEAGLE DOGS TO PROTRACTED EXPOSURE TO ^{60}Co γ RAYS AT 5 TO 35 R/DAY. IV. BACTERIOLOGIC FINDINGS. Brennan, Patricia C.; Simkins, Richard C. (Argonne National Lab., Ill.).

The high incidence of β-hemolytic streptococci and Pasteurella multocida suggests that the source of organisms associated with bacteremia is the upper respiratory tract, rather than the intestine. These bacteria are frequently inhabitants of the throats of normal, unirradiated dogs from this colony. (auth)

45895 (ANL–7535, pp 161) THE RESPONSE OF BEAGLE DOGS TO PROTRACTED EXPOSURE TO ^{60}Co γ RAYS AT 5 TO 35 R/DAY. V. PATHOLOGY. Fritz, Thomas E.; Zeman, Ruth C.; Tolle, David V.; Williams, John W. (Argonne National Lab., Ill.).

Sixteen beagle dogs were examined at death or sacrifice when moribund following protracted γ irradiation. Necropsy results showed that the macroscopic changes were not different from those expected; the principal cause of death was pancytopenia and septicemia; and hemorrhage was the most prominent lesion. In particular, a characteristic peribronchiolar hemorrhage is described that has not been reported previously as a result of either radiation toxicity or septicemia. It was concluded that the pathogenesis of this lesion may give some insight into the mechanism of post-irradiation hemorrhage. (C.O.)

45896 (ANL–7535, pp 162–3) MYELOPROLIFERATIVE DISEASE IN BEAGLE DOGS GIVEN PROTRACTED WHOLE-BODY IRRADIATION OR SINGLE DOSES OF ^{144}Ce. Fritz, Thomas E.; Norris, William P.; Rehfeld, Carl E.; Poole, Calvin M. (Argonne National Lab., Ill.).

In two experiments, protracted irradiation from different sources (injected ^{144}Ce and γ ray whole-body exposure) had produced 3 cases of myelogenous leukemia, and 5 other cases of marrow myeloproliferation associated with anemia in beagles. The demonstration of neoplastic disease after a well-defined dose of protracted whole-body γ radiation, is a most important finding. The average absorbed dose resulting from 17 R/day for 100 days was calculated to be 1325 Rad for a first approximation. (C.O.)

45897 (ANL–7535, pp 163–6) ^{137}Cs: CURRENT STATUS AND LATE EFFECTS. Poole, Calvin M.; Norris, William P.; Fritz, Thomas E. (Argonne National Lab., Ill.).

Seventy-three dogs in three age groups were injected with

^{137}Cs intravenously in 1961. Thirty of these dogs died within 64 days, with bone marrow aplasia as the major cause of death. Five more deaths occurred between 1613 and 2602 days after injection. The later pathological findings on these dogs and on other dogs still living are presented in tabular form. These pathological observations were quite varied and included neoplasms of various types and locations. Individually, these conditions were not unusual, but the total incidence was much higher than in a control population. (C.O.)

45898 (ANL-7535, pp 166-9) A STUDY OF THE THERMOREGULATORY CAPABILITIES OF NORMAL, AGED, AND IRRADIATED BEAGLES. Norris, William P.; Poole, Calvin M.; Fry, R. J. Michael; Kretz, Norbert D. (Argonne National Lab., Ill.).

Miniaturized radiofrequency transmitters were implanted in dogs to measure the thermal responsiveness to changes in environmental temperature (normal and elevated temperatures). One test compared the thermal response of a deep abdominal location with that of a shallow location along the abdominal wall. It was found that the deep location always responded faster under severe stress, but the opposite was true with a more moderate stress. A second test compared the deep thermal responsiveness of a young dog with that of a relatively old dog. Inconclusive results were obtained in this test. The third test compared responses of an unirradiated dog with one that had survived 100 days of protracted ^{60}Co γ radiation at a rate of 24.5 R/day and 972 subsequent days. The irradiated dog had no detectable abnormalities. Results showed a distinctly poorer ability of the irradiated dog to dissipate heat. It was concluded that the indication that exposure to radiation reduces thermoregulatory capability is sufficiently definite to suggest that further work be directed to this area. (C.O.)

45899 (ORO-3599-5) VISUAL CELLULAR STIMULATION BY HIGH-ENERGY QUANTA. Technical Progress Report, December 1, 1968-September 1, 1969. Dawson, William W. (Florida Univ., Gainesville. Coll. of Medicine). Contract AT(40-1)-3599. 24p. Dep. CFSTI.

Techniques for localization of the retinal excitatory influence of ionizing radiation were further developed. It was demonstrated that in developing cat retinas where morphologically distinguishable receptors are not present, x rays have approximately the same effect on signal production by visible light that they have in retinas where receptors are available for stimulation. The effectiveness of an inexpensive flash x ray instrument for retinal stim lation was tested. Although dose rates (approximately 10^6 R per second) were formidable, they were also misleading in that the actual doses available are in the milliroentgen range. This range is borderline for the production of usable retinal signals and should be considered threshold. Recommendations for suitable equipment for retinal stimulation are provided in the renewal request. New findings are reported on developing retinas with specific structural anomalies. Cold stressing was used as a means of physiologically removing receptor outer-segments as a contaminating feature for retinal research. A final series of experiments on a synaptic blocking toxin (botulinum toxin) failed to produce the desired result in the retina. Indications are that this toxin is highly selective in the peripheral nervous system but is ineffective in central tissue owing to differences in synaptic configurations. Considerable progress has been made in ability to localize effects of ionizing rays on the retina. Findings published in 1968, that indicate that receptor pigments are not required for excitation of the retina by ionizing rays, are further supported. (auth)

45900 SELECTED OCULAR EFFECTS FROM AN EXPERIMENTAL NEODYMIUM LASER. Campbell, Charles J. Trans. Amer. Ophthalmol. Soc., 66: 636-72(1968).

The effects of neodymium laser radiation (10,600 Å) on the retina, iris, cornea, and lens of the rabbit eye are reported. The energy necessary to produce lesions in the retina in each of four intensity categories is summarized. No lesions were produced by energy less than 1.5 J, and severe burns were always produced by 6 to 8 J. Severe corneal burns appeared as penetrating, white, sharply defined cylindrical defects. The opacity extended from the epithelium through the full thickness of the cornea to the endothelium. From 14 to 21 days after treatment, the cylindrical corneal opacity remained less sharply defined as a consequence of infiltrates through the adjacent stroma. Immediately after treatment, both cells and flare were often seen in the anterior chamber, if the laser beam struck the iris. The iridocyclitis that resulted when the iris was struck by the beam usually subsided within 2 weeks after the injury. Repeated treatments at one session to one site produced a massive exudative iritis. Bubbles from the impact site, and pigment granules were found in the anterior chamber. A profound miosis generally occurred. At the impact site, a small area of depigmentation was evident. Histologically, after this type of injury the iris showed disruption of the anterior layer with local dispersion of melanin granules. (BBB)

45901 REPRODUCTIVITY OF FEMALE SPANISH GOATS EXPOSED CONTINUOUSLY TO GAMMA-RADIATION. Austin, J. W.; Hupp, E. W. (Texas A and M Univ., College Station). Int. J. Radiat. Biol., 15: 363-8(1969).

Female Spanish goats were penned with males for up to 3 years and exposed continuously to ^{60}Co gamma-radiation at average doses of 0, 2, 7 or 30 R/20-hour day. The median death time for the females receiving 30 and 7 R/day was 86 and 348 days, respectively. The ability to survive in the radiation environment was the only limiting factor affecting reproductive performance of the goats. (auth)

45902 RADIOBIOLOGICAL INVESTIGATIONS WITH FAST NEUTRONS USING THE CARTILAGE CLONE SYSTEM. Kember, N. F. (Royal Free Hospital School of Medicine, London). Brit. J. Radiol., 42: 595-7(Aug. 1969).

The recovery clone system in rat growth cartilage was used in experiments with 6 MeV modal energy neutrons generated by the M.R.C. cyclotron. At a survival level of 10^{-4} the RBE was 2.1 ± 0.2. Split dose experiments with a 24-hr interval showed recovery equal to approximately 100 rads. With limbs made hypoxic with a tourniquet, the neutron OER was 1.8 ± 0.1, which compares with an x ray OER of 2.3. No qualitative differences were observed in the histological sections of the recovery clones following neutron irradiation as compared with x irradiation. (auth)

45903 ACUTE MORTALITY AND RECOVERY STUDIES IN BURROS IRRADIATED WITH 1 MVP X-RAYS. Still, Edwin T.; Page, Norbert P.; Taylor, James F.; Wisecup, William G.; Ainsworth, E. John; Leong, George F. (Naval Radiological Defense Lab., San Francisco). Radiat. Res., 39: 580-93(Sept. 1969).

The $LD_{50(30)}$ (midline air exposure) of adult female burros exposed to 1 Mvp x-rays at a rate of 7.5 R/minute was determined to be 369 R; the $LD_{50(60)}$ was determined to be 344 R. The split-dose technique, which consists of conditioning animals with a sublethal exposure and redetermining the LD_{50} at various times thereafter, was used to determine the recovery pattern after an exposure to 250 R. By this method the burro appeared to have recovered from 48% of the conditioning injury at 60 days and from 85% at 90 days. A bimodal death pattern, with peaks at 2.4 and 24.2 days, was seen in animals given single spaced exposures. This pattern was not found in the animals that survived the conditioning exposure and were later subjected to spaced exposures. Comparison of the 1 Mvp x-ray $LD_{50(30)}$ value with earlier reported LD_{50} values established an apparent exposure rate-effectiveness relationship for the burro. The pattern of recovery at 60 and 90 days was found to closely parallel the return of white blood cells to normal values. The slow recovery has been suggested to be associated with the small numbers of circulating lymphocytes that were present after the conditioning exposure. (auth)

45904 THE RELATIVE BIOLOGICAL EFFECTIVENESS OF 2.2 GeV PROTONS FOR THYMIC AND SPLENIC WEIGHT-LOSS IN MICE. Montour, J. L.; Straub, R. F.; Shellabarger, C. J. (Medical Coll. of Virginia, Richmond. Brookhaven National Lab., Upton, N. Y.). Int. J. Radiat. Biol., 15: 491-6(1969).

Ten-week-old female mice were exposed to either protons or x rays. Half the animals in each group were killed 2 to 3 days later; their body weights were measured and thymus and spleen weights determined. The remaining animals were treated in the same way 4 to 5 days after exposure. The tabulated results show a pronounced decrease in spleen and thymus weights in the mice killed 2 to 3 days after exposure with a slight increase in organ weight 4 to 5 days after exposure. It was concluded that under identical exposure conditions and dose considerations that produced an RBE of 0.87 for 30-day lethality in mice that 2.2 GeV protons have an RBE for 2 to 3 or 4 to 5 day thymic and splenic weight loss of 1.0 compared with 250 kVp x rays. (H.L.W.)

45905 LATE EFFECTS OF 32 MeV PROTON IRRADIATION IN PRIMATES. Casey, H. W.; Coogan, P. S.; Traynor, J. E. (School of Aerospace Medicine, Brooks Air Force Base, Tex.). Radiat. Res., 39: 634-42(Sept. 1969).

Studies on the long-term cutaneous effects of 32 MeV protons were conducted on rhesus monkeys after single entire body surface exposures of 280 to 1880 rad. Radiation doses of 990 to 1880 rad produced incapacitating subcutaneous fibrosis and skin ulcers of such severity that the monkeys were killed 10 to 30 months post-irradiation. The lesions in monkeys that received 990 rad were late developing as the monkeys did not experience significant acute radiation skin reactions. One 990-rad animal also developed a subcutaneous neurofibroma. Other than a mammary carcinoma in a 560-rad animal all monkeys that received 560 or 280 rad have

not exhibited significant lesions up to 4 years postirradiation. (auth)

45906 ON MOUSE STRAIN DIFFERENCES IN RADIATION RESISTANCE: HEMATOPOIETIC DEATH AND THE ENDOGENOUS COLONY-FORMING UNIT. Yuhas, John M.; Storer, John B. (Jackson Lab., Bar Harbor, Me.). Radiat. Res., 39: 608-22(Sept. 1969).

Nine inbred strains of mice have been studied in order to determine whether significant genetic influence is exerted on the radiosensitivity of the endogenous colony-forming unit (CFU), and whether a significant correlation exists between CFU survival and survival of the whole animal. Significant genetic control of CFU radiosensitivity has been demonstrated, but the number of CFU which manifest themselves in the spleen after exposure do not predict the probability of survival in an inter-strain comparison. Preliminary experiments indicate that additional factors, such as colony growth rates, colony differentiation, and strain differences in the requirement for regenerating hematopoietic tissue, must also be taken into account in an attempt to describe mechanisms of radiation resistance among inbred strains. (auth)

45907 ELECTRICAL ACTIVITY OF THE GANGLION CELLS IN IRRADIATED RETINAS. Cavaggioni, A.; Peracchia, G.; Rosati, G. (Univ. of Parma, Italy). Radiat. Res., 39: 685-704 (Sept. 1969).

The time course of the impairment of both photic and spontaneous excitation of the retinal ganglion cells of cats is described for the 2 weeks following γ-irradiation (4200 rad) and is related to morphological signs of damage. Irradiation resulted in damage to the receptor cells. This did not affect the spontaneous activity of the ganglion cells during the following first week, but later their firing rates were clearly changed. The first week was characterized morphologically by necrosis of the receptor cells. During the subsequent period vascular changes and degeneration of the neural retina became noticeable. (auth)

45908 NUCLEAR PROJECTIONS (KARYOSCHIZES) OF GRANULOCYTES AFTER WHOLE-BODY IRRADIATION: ELECTRON MICROSCOPE STUDY. Duplan, J. F.; Bessis, M.; Breton-Gorius, Janine (Institut du Radium, Paris). Nouv. Rev. Franc. Hematol., 9: 205-14(Mar.-Apr. 1969). (In French).

Appendages or projections of nuclear material in neutrophilic granulocytes increase in number after irradiation of guinea pigs in proportion to the dose. This phenomenon of karyoschizes was investigated by electron microscopy in male guinea pigs x irradiated with 200 R. At 24 to 48 hr postirradiation blood granulocytes, and at 4 to 24 hr femoral bone marrow cells, were examined. Karyoschizes appear in the form of: projections filled with chromatin; vesicles in which the wall is of nuclear origin and the contents cytoplasmic. These nuclear projections are not attached to the centriole; thus, are different from extrusions due to nuclear stretching. In certain cells nuclear clefts exist due to intranuclear membranes. It appeared that these enclosed membranes were involved in the production of karyoschizes. The presence of nuclear clefts in the myeloblastic and myelocytic stages and the delay in the appearance of the karyoschizes after irradiation (48 hr in granulocytes and 7 hr in bone marrow cells) indicate that they are an expression of nuclear injury in immature cells and are only manifested at the time of segmentation of the nucleus. (BBB)

45909 DELAYED RADIONECROSIS OF THE BRAIN IN MONKEYS. Haymaker, Webb (NASA, Moffet Field, Calif.). J. Neuropathol. Exp. Neurol., 27: 118-19(Jan. 1969).

Seven monkeys received γ or x radiation to the head in a dose of 2000 R given at 50 R/min. The latent period for lesion development was between 13 and 17 weeks. A wide range in lesion type was observed in the cerebral white matter, including coagulative tissue necrosis, which was progressive, and spongiform tissue necrosis, which appeared static. In the white matter the severity of vascular change occurring in association with some of the lesions was evident from the numerous calcific deposits. In early stages of lesion evolution, great numbers of activated mesenchymal cells pervaded focal areas of tissue, signifying a marked acuteness of the pathological process. Oligodendroglia in spatial relation to affected vessels contained myelin fragments, indicating vascular-dependent breakdown in the oligodendroglia-myelin unit. Glycogen was found in these cells. Lesions of the coagulative type were found in the cerebral cortex, and also in the hypothalamus, where the lesions had no particular localization. Many of the lesions in their incipiency could be found in spatial relation to stem vessels or to their capillary beds. Circulatory insufficiency seemed the critical factor in lesion development. (BBB)

45910 HERMAPHRODITIC GONADS PRODUCED IN ORYZIAS LATIPES BY X RADIATION DURING EMBRYONIC STAGES. Egami, Nobuo; Hyodo-Taguchi, Yasuko (National Inst. of Radiological Sciences, Chiba, Japan). Copeia, No. 1, 195-6 (Mar. 6, 1969).

The frequency of hermaphroditic gonads in male fish, O. latipes after x irradiation, and without any treatment with hormone substances, was studied. Groups of Oryzias eggs, each consisting of about 120 eggs at 8 different developmental stages were irradiated with 0.5, 1, and 2 kR of x rays. No tests were found in an intermediate state, and all are clearly classifiable into normal testes, ovo-testes, and sterile testes. A total of 935 individuals was examined. When embryos were irradiated with 0.5 to 2 kR of x rays 7 to 8 days after fertilization, testes transformed into ovo-testes in about $\frac{1}{4}$ of the males. Frequency of appearance of sterile gonads increased with size. When embryos were irradiated at 1 to 6 days postfertilization, production of ovo-testes was rare. Development of germ cells in intact embryos was observed and mitotic figures in gonia were found beginning with the seventh day after fertilization. (BBB)

45911 SKELETAL DEVELOPMENT OF MICE X IRRADIATED IN UTERO. Rugh, R.; Duhamel, L.; Osborne, A. W.; Sweeney, W. A. (Columbia Univ., New York). Amer. J. Anat., 125: 169-76(June 1969).

Since a uniform radiation exposure at different gestation ages does not reveal the variations in radiosensitivity of skeletal development, different exposure levels for the different days of gestation were given CF1 mice fetuses in attempts to detect such variability. The doses varied from 275 to 595 R, respectively, given at intervals from 0.5 day after conception to 18 days. The levels of x irradiation were previously established for each gestation day so that half of the exposed fetuses would survive for at least 30 days after birth. Those that survived to 2 months were radiographed (1174 mice, including 150 controls of both sexes) and 7 bone measurements were taken from each mouse. From conception through gestation day 10 there appeared to be no significant reduction in bone measurements as a result of embryonic or fetal x irradiation even though the exposures ranged from 100 R to 400 R. The greatest decrements followed exposure of the fetuses at days 15 and 16, although there was some reduction on days 13 and 14 also. Lateral skull measurements after 365 R at 16 days of gestation showed the greatest deficiency, amounting to 18% in the males and 21% in the females. All other bone measurements showed similar decrements. The spine measurements were first reduced when irradiation was done on day 11. In all mice the average bone measurements were slightly greater for males than females. Embryologically those days most radiosensitive with respect to skeletal growth were those when osteogenesis was the most active. There is no evidence that ionizing irradiation prior to chondrogenesis has any effect on later skeletal development. (BBB)

45912 ACTIVATION OF A MAMMARY TUMOR VIRUS IN O20 STRAIN MICE BY X IRRADIATION AND URETHANE. Timmermans, A.; Bentvelzen, P.; Hageman, Philomena C.; Calafat, Jero (Netherlands Cancer Inst., Amsterdam). J. Gen. Virol., 4: 619-21(June 1969).

In mouse mammary tumors, a virus particle (B particle) is often found associated with the genesis of the tumors. Injection of carcinogenic chemicals or whole-body irradiation of B-particle-free mice leads to the release into the serum of antigens which cross-react with a soluble antigen of the Bittner virus. Evidence supporting the hypothesis of activation of a mammary tumor virus by such treatment is presented from studies in the 020 strain of mice, highly resistant to so-called spontaneous development of mammary tumors. Two-month-old female O20 mice were given 200-rad whole-body x irradiation, while the ovarian region was shielded by lead. Two days later forced breeding of the animals was started and urethane was given continuously in the drinking water. Of the 7 treated mice, 4 developed a mammary tumor before 1 yr of age, 2 developed lymphatic leukemia, and 1 developed a uterine tumor. In the controls no mammary tumors were found before 1 yr of age. Electron microscopy of the tumors revealed budding and mature B particles. Cell-free filtrates of these induced mammary tumors were made and injected intraperitoneally into 4-week-old female BALB/c mice, which were subjected to forced breeding. One filtrate induced mammary tumors before 1 yr of age in 8 out of 10 mice; the other in 4 out of 10. Cell-free filtrates of the tumors induced in BALB/c mice by the O20 mouse tumor extract when injected into virus-free BALB/c mice produced tumors. Mammary tumors induced in BALB/c by the O20 tumor extract examined with the electron microscope showed that B particles were present, whereas they were not seen in BALB/c tumors induced by extreme hormonal stimulation. It was concluded that irradiation + urethane activates a B particle virus in mice of the O20 strain, and that this virus can be transmitted by cell-free filtrates. (BBB)

45913 STUDIES ON THE OCCURRENCE OF NEUTRONS IN THE LIVER OF RAT WITH IMPLANTED GUERIN EPITHELIOMA.

Wszolek, B.; Majewski, C.; Kukiel, E. (J. Strus Municipal Hospital, Poznan, Poland). Pol. Med. J., 7: 1162-5(1968).

Translated from Patol. Pol., 18: No. 4(1967).

Experiments were carried out to determine whether neutrons occur in the liver (analogically as in the kidneys) of rats with Guerin epithelioma implanted in the right lumbar region. Nuclear plates, type M_3, manufactured in Poland, with emulsion 100 μ thick, were employed. Lithium borate was incorporated in the emulsion. The exposed emulsions were examined under the microscope after a 6-week exposure and appropriate chemical processing. On the basis of careful measurements and of the mass, energy, and momentum conservation law applied to the products entering into and emerging from the reactions it was calculated that the tracks recorded in the emulsion submitted to nuclear reactions of the ^{6}Li and ^{10}B nuclei were caused by slow neutrons. (auth)

45914 NUCLEAR REACTIONS PRODUCED BY NEUTRONS OF THE LIVER OF RAT AFTER ORAL BERYLLIUM ADMINISTRATION. Wszolek, B.; Kukiel, E.; Majewski, C. (J. Strus Municipal Hospital, Poznan, Poland). Pol. Med. J., 7: 1166-72 (1968).

Translated from Patol. Pol., 18: No. 4(1967).

The livers of healthy rats that received by tube 1 ml of 0.060 g/ml $Be(OH)_2$, as well as livers of rats not treated with beryllium were investigated, using track autoradiography. After a 6-week exposure, in the first group (beryllium-treated animals) nuclear reactions produced by neutrons with $^{10,11}B$ nuclei incorporated into the nuclear emulsion and the recoil protons were recorded. In the second group (animals not treated with beryllium) recoil protons were observed in the emulsion. The results indicate that administration of beryllium enhances the intensity of nuclear processes. Simultaneous exposure of controls did not show the presence of these processes.

45915 EXPERIMENTAL STUDIES OF THE BIOLOGICAL EFFECT OF ELECTRO-MAGNETIC WAVES OF A MILLIMETER RANGE. Gordon, Z. V.; Lobanova, E. A.; Kitsovskaya, I. A.; Tolgskaya, M. S. (Inst. of Labor Hygiene and Prophylaxis, Moscow). Byull. Eksp. Biol. Med., 68: No. 7, 27-9(July 1969). (In Russian).

Reports on studies of biological effects of electromagnetic waves of a millimeter range (functional state of the central nervous system, cardiovascular system and morphological picture) in acute and chronic experiments on animals are given. Data obtained point to weakening of the main nervous processes, changes of the blood pressure level and to the presence of morphological changes in the central nervous system. Data further show differences in the biological effect of millimeter waves as compared to the centimeter and decimeter waves which is possibly caused by the depth of their penetration. (auth)

45916 EFFECT OF WHOLE-BODY AND PARTIAL-BODY X-IRRADIATION ON THE EXTRACTABLE CELLULAR COMPONENTS OF THE LUNG WITH SPECIAL CONSIDERATION TO THE ALVEOLAR MACROPHAGE. Moyer, Robert F.; Riley, Richard F. (Univ. of California Center for the Health Sciences, Los Angeles). Radiat. Res., 39: 716-30(Sept. 1969).

Female Sprague-Dawley rats were given various whole-body and partial-body x-ray exposures to determine the radioresponsiveness of extractable cellular components of the lung. Cellular suspensions were obtained from the lung by intratracheal lavage with a balanced salt solution. Exposure of the thorax to 1000 rad and whole-body irradiation at three dose levels (500, 750, and 1000 rad) all reduced extractable alveolar macrophage numbers to approximately 50% of control values during the second week after irradiation. Recovery was indicated by the fourth week. The number of polymorphonuclear leucocytes extracted from the lung increased to approximately ten times control levels during the third post-irradiation week and subsequently decreased in an exponential manner. Small aphagocytic mononuclear cells were recovered from lungs of all control rats. Their numbers were reduced prior to the third week after irradiation. Mean macrophage diameters and the frequency of binuclear macrophages were increased following x-ray exposure and reached maximal values during the third week after irradiation. An increase in lung weight following irradiation also was demonstrated. The cellular extraction procedure has been shown to be capable of providing quantitative information on cellular dynamics within the respiratory passages of the lung. (auth)

45917 EVOLUTION OF A CIRCUMSCRIBED NECROTIC AREA IN THE AXIS OF THE CHICK EMBRYO, INDUCED BY IRRADIATION WITH ULTRAVIOLET RAYS. Sandor, S.; Elias, S. (Research Center for Normal and Pathological Embryology, Timisoara, Rumania). Rev. Roum. Embryol. Cytol., Ser. Embryol., 5: 173-80(1968).

To investigate the development of a circumscribed necrotic area within the embryo, an experimental model was created by using the localized uv (high-pressure Hg vapor lamp used, i.e., 2573 Å) irradiation of a portion of the axis of the 36-hr incubated chick embryo. Irradiation was carried out both in vitro and in ovo (with the aid of a method compatible with the subsequent development of the embryo). Development of the necrotic area was followed by serial photographs, time-lapse cinematography, and by histological and histochemical preparations (hemalum eosin, Feulgen reaction, Brachet staining) at various intervals after irradiation. In the irradiated area during the first 1 to 3 hr a progressive opacity appeared, corresponding to a stepwise developing necrobiosis and necrosis of the axial tissues and primordia. Morphologically, the necrotic process was similar to other necrotic processes seen in the embryo (normal spontaneous necrosis or cell death induced by several exogenous injurious agents). The main morphological sign of developing necrosis was the appearance of cytolysomes and phagosomes within the cytoplasm. They contained both DNA and RNA. At about 3 hr after irradiation, necrosis was practically total. It began earliest within the wall of the neural tube. Later, at 24 to 48 hr after irradiation, in the damaged area defects of the embryonic axis appeared, the degree of which depended on the dose of irradiation. These defects included lack of some somites and subtotal transsection. The transsection seen was not a true malformation, but represented a consequence of a circumscribed necrotic area within the embryo. (BBB)

45918 EFFECTS OF WHOLE-BODY X IRRADIATION ON A SINGLE KIDNEY IN THE DOG. Liu, Ching-tong (Baylor Univ., Houston, Tex.); Overman, R. R. Invest. Urol., 6: 485-92(Mar. 1969).

The response of one kidney to whole-body x irradiation was studied in 12 mongrel dogs, divided into two equal groups. Group I, all female, was used for measuring renal clearances. Group II, of both sexes, was employed for renal metabolic studies. Right uninephrectomy was performed in all dogs five weeks before a single exposure of 550 R. Following uninephrectomy, the plasma concentrations of various electrolytes, osmotic pressure, urea, and glucose were within normal range, indicating that homeostasis was maintained by the remaining kidney. When the uninephrectomized animals were irradiated, they survived about one week without change in the excretory and reabsorptive patterns of electrolytes. Furthermore, the filtration fraction, osmotic clearance, maximal tubular secretion of p-aminohippurate, and maximal tubular reabsorption of glucose were not significantly altered. However, the plasma urea concentrations were elevated three days postirradiation and urea clearance was also significantly increased shortly before death. The effective renal plasma flow, total renal blood flow, and glomerular filtration rate were slightly augmented. The effects of irradiation on arterial and venous concentrations of various constituents and electrolytes in the uninephrectomized dog are also stated. Some arterio-venous differences were demonstrated for oxygen, nonesterified fatty acid, and lactic acid, while glucose and electrolytes showed little or no difference. Following irradiation, the renal oxygen consumption was significantly increased, with no change in renal blood flow. Although lactic acid and nonesterified fatty acid concentrations were reduced in both arterial and venous blood in the irradiated uninephrectomized dog, the renal uptake did not show significant change. However, a trend of reduced utilization of nonesterified fatty acid and increased uptake of lactic acid by the single remaining kidney was demonstrated. (BBB)

45919 RELATIVE BIOLOGICAL EFFECTIVENESS OF 3-GeV PROTONS ON THE RAT AND STUDY OF THE RADIORESTORATION RELATIVE TO γ RAYS FROM ^{60}Co. Legeay, G. (Department de la Protection Sanitaire, Fontenay-aux-Roses, France); Guenet, J. L.; Tardy-Joubert, Ph.; de Kerviler, H. Radioprotection, 4: 65-82(1969). (In French).

A study was made of the process of consecutive restoration from irradiation by 3-GeV protons on the rat. This restoration was compared with that following an irradiation by ^{60}Co photons taken as a reference. The technique of fractionated dose was used that consisted of a conditioning radiation followed, after a variable time interval, by an irradiation revealing the damage due to the conditioning dose. This permitted the RBE to be established for 3-GeV protons on the rat for the test of 50% lethality under conditions of an individual exposure in air. (J.F.P.)

45920 EFFERENT SYMPATHETIC ACTIVITY OBTAINED FROM THE MIXED NERVE CORD OF THE FROG IN THE IMMEDIATE POST-RADIATION PERIOD. Chepurnova, N. E.; Chepurnov, S. A.; Laprun, I. B.; Shcheblanov, V. Yu. (Moscow Univ.). Dokl. Akad. Nauk SSSR, 185: 236-9(Mar. 1, 1969). (In Russian).

The activity of the autonomic nervous system (ANS) can be determined from potential readings. The efferent sympathetic

activity (ESA) is a sensitive indicator of the VNS during inflammation, use of novocaine, and x ray irradiation. The afferent and efferent fibers of the gluteal plexus in the frog were cut at the entrance of the connecting branches of the 8th to 10th sympathetic ganglia. Fine silver electrodes separated at a distance of 3 mm were inserted under the tibial nerve to obtain potential readings. The x ray dose to the whole body or head was 0.6, 1, or 4 kR. Three kinds of nerve pulse discharges were noted in the experiments. A great increase in pulse discharge was noted at 10 to 12 min after irradiation with a maximum in the amplitude of the pulse discharge being attained 20 to 30 min after irradiation. The interval between pulses was also smaller. The pulse amplitude was not constant, but varied from 10 to 30 microvolts. Occasionally a pulse of >100 microvolts was noted. (TTT)

45921 HISTOLOGIC EFFECT OF FRACTIONATED DOSES OF SELECTIVELY APPLIED MEGAVOLTAGE IRRADIATION ON THE MAJOR SALIVARY GLANDS OF THE ALBINO RAT. Elzay, Richard P.; Levitt, Seymour H.; Sweeney, W. Timothy (Medical Coll. of Virginia, Richmond). Radiology, 93: 146-52(July 1969).

The results of application of fractionated megavoltage γ irradiation to the major salivary glands of rats were not as deleterious as those previously described following fractionated orthovoltage irradiation. Mild inflammation of the interlobular stroma was noted with mild-to-moderate atrophy and pleomorphism of the acinic cells. Parenchymal degeneration and/or necrosis with subsequent replacement fibrosis or aberrant repair (adenoma formation) was not observed in any of the animals. Hence, all morphologic changes were reversible. Animals tolerated a maximal dose of 7,200 rads under the conditions of this study. (C.H.)

45922 RBE OF PROTONS WITH ENERGY GREATER THAN 126 MeV. Ueno, Y. (Kyoto Univ.); Grigoriev, Yuri G. Brit. J. Radiol., 42: 475(June 1969).

The relative biological effectiveness (RBE) of protons with energy greater than 100 MeV was estimated on the basis of experimental data previously published. Twenty experiments dealt with cytological changes and organ atrophy in mammals and 32 with mortality rate of mammals. The range of proton energy used was 126 to 730 MeV. As a baseline for RBE, 200 kVp x rays were used. The mean value of RBE in the cytological change and organ experiments was 0.80 ± 0.20 and in those on mortality rate 0.86 ± 0.18, the overall RBE being 0.82 ± 0.26. Since no significant difference (X^2) was observed between the two RBEs, a single value of 0.82 ± 0.26 (S.D.) or 0.82 ± 0.4 (S.E.) was assigned. It was suggested that the similarity of RBE for both experimental situations indicated that damage to cells caused by protons was the major factor in death of mammals. (C.O.)

45923 CHROMOSOME REARRANGEMENTS AFTER LOW X-RAY DOSES GIVEN TO SPERMATOGONIA OF MICE. Leonard, A.; Deknudt, Gh. (Centre d'Etude de l'Energie Nucleaire, Mol, Belgium). Can. J. Genet. Cytol, 10: 119-24(Mar. 1968).

Male mice from the BALB/c strain were given whole-body irradiation at doses of 25, 50, 75 and 100 R of x-rays. Seventy days after irradiation the mice were killed, the testes removed and meiotic preparations were made using an air-drying method. Translocation configurations involving four chromosomes were the most frequent type recorded. The percentage of translocations increased regularly from 0.42 after 25 R to 1.96 after 100 R. The relationship between the x-ray dose and the rate of abnormal cells appears to be linear with a regression coefficient of $b = 0.018960$. (auth) (CAN)

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Refer also to abstracts 45575, 45661, 45711, 45752, 45768, 45771, 45790, 45792, 45793, 45797, 45826, 45854, 45855, 45857, 45858, and 45870.

45924 (JPRS-48511, pp 21-32) BIODETECTION OF SMALL RADIATION DOSES DISCUSSED. Plecas, Vojislav; Pendic, Branislav; Dragovic, Milica. Translated from Narodno Zdravlje, No. 3, 102-6(1969).

A review is presented of various factors influencing biological changes following exposure to small doses of ionizing radiation. Values for the relative biological effectiveness of different types of radiation are listed. A list of mammalian tissues in descending order of their radiosensitivity is presented. Effects of γ and x radiation in doses of 0.02 to 0.1 R on human blood are discussed. Latent effects of long-term irradiation on the human, including reduced longevity, tendencies to contract cancer, and tendencies to contract leukemia, are discussed. (H.L.W.)

45925 ON A RARE CASE OF RAPIDLY DEVELOPING HISTIOID LEUKEMIA APPEARING AFTER RADIOTHERAPEUTIC AND ANTIBLASTIC TREATMENT OF RETINOBLASTIMA. Magnasco, A.; Zingirian, M.; Cottafava, F. (Univ., Genoa). Ann. Ottalmol. Clin. Oculist., 93: 300-8(Mar. 1967). (In Italian).

A case of retinoblastoma in a four year old child whose death was due to histioid leukemia is described. Attention is drawn to the rarity of such an occurrence and a discussion is made of the probable connection existing between the ocular affection and the systematic disease. Various explanations are given and the more likely one is that of radio leukosis caused by roentgentherapy and antiblastic treatment sustained by the little patients. It is argued, however, that similar cases in the past may have been misrepresented and that mortality of those patients has been ascribed to the primary tumor only. (auth)

45926 STUDIES ON THE RADIOSENSITIVITY OF THE CERVICAL CANCER. 1. HISTOLOGICAL CHANGES OF CARCINOMATOUS PORTIO VAGINALIS CAUSED BY IRRADIATION. 2. HISTOLOGICAL FINDINGS WHICH PREDICT GOOD IRRADIATION RESPONSE. Nagata, Takahito (Gifu Univ., Japan). Gifu Ika Daigaku Kiyo, 16: No. 12, 63-92(Dec. 1968). (In Japanese).

Histological examination of the changes caused by irradiation of vaginal carcinomas in 29 cases showed that the changes begin with the suspension of mitosis, followed by the swelling of nucleus, the enlargement of nucleolus, the swelling of cytoplasm, increase of the number of PAS granules, vacuoles formation in cytoplasm, and pyknosis, resulting in karyorrhexis. It was also observed that the radiosensitivity of these cancer cells was much greater than that found in the reactions in the surrounding tissues. A considerable difference was recognized among individual cases of the extent of damage upon the cancer cells caused by irradiation. It was concluded that in cases that show abundant vessels and a lot of mast cells in the surrounding tissues, and have small nucleoli in the cancer cells before irradiation, a good response to irradiation can be expected. Thus the mere microscopic observation of these three factors in the histological specimen before irradiation can predict the effect of the irradiation. This is a considerable contribution to selective therapy. (NSA of Japan)

45927 THE LATE RESULTS OF RADIUM TREATMENT FOR BENIGN UTERINE HAEMORRHAGE. Dickson, Robert J. (Mount Vernon Hospital, Northwood, Eng. London Clinic). Brit. J. Radiol., 42: 582-94(Aug. 1969).

A total of 1,817 patients treated at the Marie Curie Hospital with radium for functional uterine haemorrhage was followed for at least 10 yrs or until earlier death. A considerable increase in the incidence of uterine carcinoma was found in these patients and the possible causes are discussed. No significant increase in incidence of extra-uterine malignant disease or of the leukaemia was demonstrated. Permanent amenorrhoea was not produced in all patients and of more than 30 attempted pregnancies, six full-term births resulted. No genetic changes attributable to the irradiation were noted in these or in one second generation offspring. The conclusion is reached that if irradiation is used to produce an artificial menopause, external pelvic radiotherapy is to be preferred to intra-uterine radium. (auth)

45928 SHORT TERM EFFECTS OF RADIATIONS ON THE GASTRIC AND RECTAL MUCOSA. PRESENTATION OF 2 CASES. Delage, C.; Bernier, L. (Hotel-Dieu, Quebec). Union Med. Can., 98: 1314-20(Aug. 1969).

Two cases of post-radiation lesions to the stomach and rectum are presented. The first observation deals with a 43 year old male who received radium therapy to the fundic region of the stomach for a recurrent peptic ulcer. The second observation concerns a 45 year old female to whom whole pelvis radium therapy was delivered for bone metastases of a primary endometrial adenocarcinoma anteriorly resected. In both the stomach and rectum, the lesions are limited to the mucosa; they consist of a subacute inflammatory process with, on the one hand, necrotic foci of a few glandular tubules and, on the other, some particular cellular atypias that must not be confused with areas of epitheliomatous transformation. Moreover, in the case of radiation rectitis the presence of cryptic eosinophilic microabcesses is stressed. These abcesses seem to be quite characteristic. (auth)

45929 RADIO-CANCER OF THE ETHMOID IN A YOUNG GIRL OF 15. Paufique, L.; Papillon, J.; Gaillard, J.; Bouchayer, M.; Dumolard, P. J. Fr. Oto-Rhino-Laryngol., 16: 565-7(Nov. 1967). (In French).

The case history of a 15-year old girl with radioinduced cancer of the ethmoid is presented. The child was treated with radiotherapy for retino-blastoma at one year of age. Fourteen years after the treatment of the bilateral retinal glioma, epistaxis led to examination that revealed the existence of a chondrosarcoma in the nasal fossa. Cobalt treatment did not cure the sarcoma and surgery was undertaken. Eight months after the surgery there was no sign of local or general evolution of the cancer. The factors leading to radioinduced cancers after x-ray treatment of retinal

tumors are discussed. The latency period, the nature of the secondary tumors, and the circumstances of the detection of the secondary cancer are considered. (J.S.R.)

45930 A DRAMATIC CASE OF SPINO-CELLULAR EPITHELIOMA OF RADIODERMITIS OF THE SCALP. Vanbremeersch, F.; Preaux, J.; Texier, M. Bull. Soc. Fr. Dermatol. Syphiligr., 74: 830-2(1967). (In French).

A presumed radioinduced spinocellular epithelioma which developed in a 38-yr-old woman 31 yr after radiotherapy for a benign scalp condition is reported. Acute radionecrosis of the scalp and ears developed, and large ulcerated, infected areas persisted, for which the patient was treated over a 3-yr period. Nine yr after irradiation grafting was used to cover 80% of the lesions, and at that time no malignant cells were noted in biopsied material. Seven yr later 2 large (7 × 5 cm) ulcerated areas in the occipital region were treated, and a spinocellular epithelioma was noted in one lesion. More grafting was done and the tumor removed, but healing was incomplete. When the most recent treatment of the patient was begun, 21 yr postirradiation, there was little healthy tissue on the scalp and the left ear had disappeared. A more extensive tumor was present along with severe radiodermatitis. (BBB)

45931 EQUILIBRIUM THERMAL MODEL FOR RETINAL INJURY FROM OPTICAL SOURCES. Clarke, A. M.; Geeraets, Walter J.; Ham, William T. Jr. (Medical Coll. of Virginia, Richmond). Appl. Opt., 8: 1051-4(May 1969).

A uniform absorption thermal model is described that allows the calculation of the temperature rise in the retina due to steady state or continuous optical laser irradiation. Temperature rises of 9 to 10°C were found to correspond to the production of threshold lesions. For a worst case approximation, a power of 1 to 2 mW entering the eye and focused onto a 10 μ diam area for 250 msec or longer can be shown as sufficient to cause irreversible damage. (auth)

45932 PRIMARY MALIGNANT TUMORS OF THE HAND. Kendall, Tom E.; Robinson, David W.; Masters, Frank W. (Univ. of Kansas, Kansas City). Plast. Reconstr. Surg., 44: 37-40(July 1969).

Radiation injuries were noted in a relatively large proportion of 73 patients treated for tumors of the hand. Squamous cell carcinoma was the most common primary malignant tumor of the hand, comprising 78% of all malignancies seen. Fifteen patients gave a positive history of x-ray exposure and/or had evidence of chronic radiodermatitis. In 5 other cases, trauma or chemicals were considered to be possible etiologic agents. Treatment of these malignancies consisted of excision, amputation, lymph node dissection, and radiation therapy, depending upon the local extent of involvement and the presence or absence of regional or distant metastases. Radiotherapy was reserved for inoperable situations where temporary palliation was indicated. Two patients treated by local excision had baso-squamous cell carcinoma; one gave a history of exposure to radiation. From these and other studies, it is apparent that malignancy in the hand may be etiologically related to heredity, disturbance of metabolism, radiation, and trauma. Most squamous cell carcinomas occur on the dorsum of the fingers or the hand; the palm is rarely involved. Basal cell carcinoma, carcinoma-in-situ, and baso-squamous cell carcinoma usually occur as a result of prolonged exposure to sunlight. Persons who have been exposed to heavy doses of x rays also tend to develop these tumors. Since basal cell carcinoma almost never occurs on the palm of the hand, nearly all can be treated by wide local excision and skin grafting; amputation is rarely necessary. Radiotherapy should be used seldom, and only as an alternative method for special cases. (BBB)

45933 INVESTIGATION OF THE EFFECTS OF PRENATAL X-RAY EXPOSURE OF HUMAN OOGONIA AND OOCYTES AS MEASURED BY LATER REPRODUCTIVE PERFORMANCE. Meyer, Mary B. (Johns Hopkins Univ., Baltimore); Merz, Timothy; Diamond, Earl L. Amer. J. Epidemiol., 89: 619-35(June 1969).

An epidemiologic study tested the hypothesis that oocytes at a sensitive stage in fetal life might be damaged by the levels of x-ray exposure used in pelvimetry, and might exhibit this damage in some way that could be detected in the F_2 child. Negro females (1500) born in Baltimore hospitals in 1947-1952 who were exposed to x-ray in utero and 1500 matched controls were studied on the basis of 1100 F_2 births to these F_1 mothers. Exposed mothers had higher birth rates than controls, but similar rates of neonatal deaths, fetal deaths, and ascertained abortions. Most comparisons of exposed vs. control F_2 births failed to show a significant increase in the problems encountered by exposed mothers in pregnancy and labor, or in the condition and course of their babies. On the other hand, when F_2 births were analyzed by the time during fetal life when the F_1 exposure occurred, differences were observed. The F_1 mothers exposed before 30 weeks of fetal life bore significantly more male babies and fewer female babies compared with F_1 mothers exposed later in fetal life, or compared with controls. These babies had longer gestations and lower Apgar scores. Placenta weights were lower, and more mothers in this group had precipitate labors. Babies born to mothers exposed at 37 or more weeks of gestation had significantly more neonatal jaundice. Several mechanisms may explain the altered sex ratio in progeny of irradiated females, one through a hormonal change induced by irradiation of the fetal F_1 ovaries. This might act in a way leading to preferential survival of male offspring. Or, irradiation of female germ cells may yield dominant X chromosome lethals which would affect offspring of both sexes equally, and recessive lethals which should reduce the number of males. (BBB)

45934 A CASE OF NEUROFIBROMATOSIS COMPLICATED BY MEDULLOBLASTOMA, NEUROGENIC SARCOMA, AND RADIATION-INDUCED CARCINOMA OF THYROID. Corkill, A. G. L. (Government Hospital, Tripoli, Libya); Ross, C. F. J. Neurol., Neurosurg., Psychiat., 32: 43-7(Feb. 1969).

Radioinduced thyroid carcinoma with metastatic involvement of a sarcomatous nerve tumor is described in a boy with Von Recklinghausen's disease, that was complicated by a medulloblastoma of the cerebellum, and multifocal malignant change in the neurofibroma. After the surgical removal of the medulloblastoma he was given radiotherapy. A dose of 2975 R was given, that was well tolerated apart from a temporary leucopenia of 2400 white cells/mm^3. It was estimated that the thyroid gland received a dose of 800 R during the course of treatment. He remained well until 9 yr later, when the subcutaneous swellings and cafe-au-lait spots of Von Recklinghausen's disease were evident and it was noticed that he had a prominent, firm thyroid gland. At autopsy a thyroid carcinoma was found. It is postulated that the radiation that brought about the cure of the medulloblastoma unfortunately induced malignant change in the thyroid. (BBB)

45935 EPIDEMIOLOGIC STUDIES IN HUMAN RADIOBIOLOGY. Bol. Ofic. Sanit. Panamer., 66: 552-63(June 1969). (In Spanish).

Recent findings in the epidemiology of radiation effects are reviewed. The evidence relating leukemia to previous radiation exposure is presented, and here a definite correlation is evident. This is based on studies in Japanese atomic bomb survivors, patients treated with x rays for ankylosing spondylitis, and infants irradiated in utero during maternal radiodiagnosis studies. Persons developing thyroid cancer after neck irradiation in childhood and malignant tumors years after receiving Thorotrast for radiography constitute other evidence for the neoplastic effect of ionizing irradiation. The development of lung cancer in uranium miners in Colorado and Czechoslovakia is cited as further evidence of radiocarcinogenesis. Thyroid tumors arising from previous irradiation have been documented in many studies, particularly by external radiotherapy. However, clinical evidence for radioiodineinduced thyroid cancer is less impressive, although some Marshall Islanders developed thyroid nodules after large accidental doses of fallout radioiodine. The long-term prospects for radiocarcinogenesis in view of increasing levels of environmental radiation are speculated upon. (BBB)

45936 ULTRASTRUCTURE OBSERVATIONS OF RADIATION RESPONSE IN ORAL EXFOLIATIVE CYTOLOGY. Silverman, Sol Jr. (Univ. of California, San Francisco). Acta Cytol., 13: 292-301(May 1969).

The fine structure of oral epithelial scrapings from patients undergoing cancerocidal irradiation for oral carcinoma was examined to determine the cellular radiation response and to differentiate benign and malignant cells. The 23 cancer specimens were obtained preirradiation, during the first half of irradiation (less than 3000 R), during the second half of irradiation (3000 to 6000 R), and postirradiation. Leukoplakia specimens also were obtained to assess cytoplasmic acidophilia which occurs in response to irradiation and which may reflect increased keratin formation. Malignant cells differed from normal cells by such features as numerous multivesicular bodies, increases in Golgi complexes and endoplasmic reticulum, and a marked diminution of cytoplasmic fibrils. Ultrastructural changes of cells exposed to radiation were variable and possibly explain the erratic biologic responses of tumors. Nuclear and cytoplasmic damage sometimes occurred independently. Alterations were generally characterized by increases in cytoplasmic fibrils, vacuoles, and lysosomes; altered mitochondria and endoplasmic reticulum; disruption of nuclear DNA; and rupture of membranes. Some cells did not reveal any morphologic changes. The relations between function and structural damage, reversibility, nuclear-cytoplasmic interaction, and cell survival are discussed. (BBB)

45937 RECOIL PROTONS IN LIVER AND KIDNEYS. Majewski, C.; Wszolek, B.; Kukiel, E. (J. Strus Municipal Hospital, Poznan, Poland). Pol. Med. J., 7: 1173-7(1968).

Translated from Patol. Pol., 18: No. 4(1967).

Recoil protons are recorded in nuclear emulsions when dehydrated homogenates of renal clear-cell carcinoma, Guerin epithelioma, and liver and kidneys of rats with implanted Guerin epithelioma were exposed. Recoil protons were formed as a result of elastic collision of fast neutrons with hydrogen atoms from nuclear emulsion. The described phenomena may play an important role in living organisms in which hydrogen is one of the fundamental elements. (auth)

45938 RADIATION DOSAGE AND COMPLICATIONS IN CERVICAL CANCER THERAPY. Peckham, Ben M.; Kline, Joyce C.; Schultz, Alwin E.; Cameron, John R.; Vermund, Halvor (Univ. of Wisconsin, Madison). Amer. J. Obstet. Gynecol., 104: 485-94(June 15, 1969).

Computerized dosimetry in 346 patients treated by a combination of intracavitary and supervoltage radiotherapy permitted a detailed analysis of dose delivered and an analysis of severe complications in relation to dose. The radiation delivered to the bladder, rectum, paracervical area, and the pelvic wall is described for a technique in which a calculated bladder and rectal tolerance was used as the limiting factor for total central dose. Rectovaginal and vesicovaginal fistulas occurred in only 1.4% of the patients, but other serious bowel and ureteral complications were seen in 6.4%. There were 16 severe bowel injuries (8 necrosis and/or perforation and 8 obstructive). In addition, there were 18 cases of proctitis and 16 of cystitis. Three other serious complications included 1 severe pelvic infection requiring exploration and 2 bone complications (necrosis of the femoral head and a traumatic subcapital fracture). Most injuries occurred in patients in a relatively early stage of disease. No significant correlation could be found between dose ranges in the bladder, rectum, or paracervical area and complications. However, there was a significantly greater number of bowel and ureteral complications in patients receiving 2 intracavitary applications compared with only 1. (BBB)

45939 MEDICAL BASIC PRINCIPLES WHICH SERVE AS THE BASIS FOR THE BODY OF REGULATIONS CONCERNING IONIZING RADIATION. LaFontaine, A. (Instituut voor Hygiene en Epidemiologie, Brussels). Bull. Belgicatom, 12: 19-22(May-June 1967). (In Flemish).

A radiobiological effect depends on the quantity of energy absorbed by living matter. Factors governing this include the spatial and temporal propagation of radiation in the organism, and the type of radiation and the kind of irradiated tissue. General characteristics of radiopathological effects are the variety of symptoms, general nonspecificity, and appearance as combined effects. There may be a very long latent period. Radiopathological effects are briefly described for the head, hematopoietic organs, legs, eye, and sex organs. Effects of total-body irradiation are described, with emphasis on the acute irradiation syndrome; irradiation of the fetus may produce congenital malformation. Genetic influences include dominant and recessive mutated genes. The relation between dose, effect, and radiation protection is described. The simplest chemical radioprotective agents, MEA and AET, are noted. Physicians are urged to acquire special knowledge of radiation problems. (BBB)

45940 EFFICIENCY AND LIMITATIONS OF LASERS AS WEAPONS. Meyer-Arendt, Jurgen R. (Pacific Univ., Forest Grove, Oreg.). Amer. J. Optom., 45: 188-91(Mar. 1968).

Biological effects of laser radiation, particularly in the eye, are reviewed and the use of lasers as military weapons is considered. Laser radiation entering the eye will be focused on the retina, increasing the energy density by at least 100 times. This energy is then absorbed primarily by the pigment in the retinal epithelium. Even at low irradiance the pigment epithelium becomes disorganized. In more severe cases the epithelium can virtually explode, forming vapor bubbles and causing severe hemorrhages surrounding the vaporized and destroyed tissue. Most of this is due to heat effects although pressure waves, ionization, and, perhaps, gaseous plasmas may also play a role. The typical lesion in the retina consists of 3 zones. In the center, pigment granules are severely disarranged and dislodged. Some black pigment may actually be ejected into the vitreous humor. A hemorrhage is often found in front of the retinal lesion. A marked decrease in certain enzyme activities may be found with even the slightest damage, and such lesions occur first at the hot spots of a laser beam, the regions of slightly higher energy density within a beam of non-uniform energy distribution. This explains why minimal lesions can be smaller than the actual diameter of the laser beam on the retina. In severe cases, the choroid is damaged as well. From the center, heat is dissipated by conduction and this produces a surrounding zone of edema and coagulation. This zone, in turn, is surrounded by a region showing some orange discoloration and other disturbances in the normal pigment distribution. The threshold above which retinal lesions develop is ~0.72 J/cm^2 with a conventional ruby laser. (BBB)

45941 A DRAMATIC CASE OF SPINO-CELLULAR EPITHELIOMA ON RADIODERMATITIS OF THE SCALP. Vanbremeersch, Fr.; Preaux, J.; Texier, M. Bull. Soc. Fr. Dermatol. Syphiligr., 74: 803-2(1967). (In French).

The case history of a woman, aged 38 yrs, with spino-cellular epithelioma on radiodermatitis of the scalp is reported. The woman had received an overexposure from radiotherapy resulting in acute radionecrosis of the scalp and ears. She was under treatment for 3 yrs, then after a lapse of 6 yrs she again needed treatment for vast infected ulcerations of the scalp. Seven yrs later she was again under treatment for benign ulcerations and a spino-cellular epithelioma. Both times she refused to complete the course of treatment. Two yrs later, in 1967, she again was under treatment for occipital malignant tumor. Surgical treatment was planned, but the patient developed a massive occipital invasion that made the surgery impossible. The patient was put under alleviation treatment and died in July 1967. (J.S.R.)

45942 BONE CHANGES IN OCCUPATIONAL RADIODERMATITIS. Kolar, J.; Vrabec, R.; Jirasek, L.; Bek, V.; Peskova, H. (Charles Univ., Prague). Acta Chir. Plast., 10: 74-80(1968).

Bone changes in 84 patients with occupational damage to the skin caused by radiation were evaluated and classified. Most patients were physicians and laboratory technicians working with various kinds of ionizing radiation, in most cases x-ray apparatus. All showed chronic radiation changes in the skin, i.e., atrophy, telangiectasia, fissures, erosion, ulceration, and hyperkeratosis. In more than 80% of the patients there were malignant changes. The bone changes induced by the direct effect of irradiation of the bone and secondarily by restriction of nutrition of bone due to damage to the vessels by radiation may be of concern in therapy, especially for plastic surgical operations. Investigation of the condition of the bone is considered an indispensable part of the preoperative examination in these patients. Bone injury is accompanied by osteoporosis, which is more marked at the ends of the tubular bones of the hand especially in the phalanges. Reconstruction of bone occurs first in the distal and medical phalanges, then in the basal ones and only in a considerably advanced stage at the ends of the metacarpals. The basic features of the rebuilding process are those of hypertrophic osteoporosis; the compact bone in the phalanges is usually thinned. Some of the trabeculae of the spongiosa are disordered and the remaining ones thickened. Changes in the joints are, as a rule, found only in cases with severe damage, i.e., in those with advanced atrophy, ulcerations, and hyperkeratoses of radiation origin. They appear as a slowly progressing eroding arthritis that, in patients after therapeutic irradiation, usually affects a single joint. In occupational injury to the hands interphalangeal joints are affected. In the radiographs, the first signs consist in marginal erosions on the edges of the articular surfaces that gradually become more extensive and finally show a picture of advanced eroding arthritis with destruction of the articular surface. (BBB)

45943 MEDICAL CONSEQUENCES OF RADIOACTIVE POLLUTION. Dunham, C. L. (Atomic Energy Commission, Washington, D. C.). ADM (Rev. Asoc. Dent. Mex.), 24: 153-8(Mar.-Apr. 1967). (In Spanish).

An assessment is made of the extent of distribution of radionuclides in the biosphere as a result of nuclear testing and increasing use of nuclear sources of power, as well as of the risks of contamination and of the known biological effects of radiation. Levels of ^{90}Sr, ^{137}Cs, ^{14}C, ^{129}I, and ^{239}Pu released by nuclear testing are discussed. Surface tests equivalent to 511 Mt of TNT released ~20 MCi of ^{90}Sr into the atmosphere. The carcinogenic potential of these radionuclides are considered. Tables are given which show the projected number of genetic defects and of leukemia and osteosarcoma expected from fallout radiation in the United States. It is suggested that man-made radiation levels are low compared with other environmental and medical sources of irradiation, and that the risks to future generations are very small. (BBB)

45944 RESULTS OF RADIATION TREATMENT OF BLADDER CARCINOMA WITH ULTRAHARD X RADIATION FROM A 17-MeV BETATRON. Vieten, H.; Guenther, D. (Univ., Duesseldorf). Urologe, 6: 83-7(Mar.-Apr. 1967). (In German).

Complications of treatment of bladder carcinomas with high-voltage (17-MeV) betatron irradiation were discussed. The greatest danger of this type of irradiation was development of radiogenic cystitis due to extremely rapid disintegration of the tumor. This was particularly true in inoperable patients where irradiation was the only treatment feasible. In order to prolong

the destruction of the tumor the daily irradiation dose was kept at 150 R. This resulted in fewer and less severe cases of irradiation cystitis, as compared to those who received 250 R/day. In general, high-voltage betatron irradiation seemed to be tolerated better than ^{60}Co irradiation. Even though the doses of betatron irradiation were relatively high, there were no cases of radiogenic connective tissue fibroses that produced ureteral stenoses. In several patients who had partial or total ureteral blockage before irradiation treatment the flow impediment was lessened after radiation treatment with high-voltage betatron irradiation. (BBB)

45945 THYROID DEPRESSION FOLLOWING SPLENIC IRRADIATION IN LYMPHOMA PATIENTS. Logan, J. W. (Wellington Hospital, New Zealand). Australas. Radiol., 13: 161-3 (May 1969).

Irradiation of lymphomatous tissue may be followed by inactivation of thyroid stimulating hormone (TSH), leading to depressed thyroid uptake. In three patients with malignant lymphomas with enlarged spleens, given radioactive iodine before and during splenic irradiation thyroid uptake was significantly depressed. In two with a myeloproliferative form of polycythaemia, given irradiation to enlarge spleens, there was no significant depression. It was concluded that radiotherapy caused breakdown of lymphomatous tissue in the spleens, leading to increased inactivation of TSH. In contrast, epigastric irradiation in patients raised thyroid uptake. A separate direct effect of radiation on the autonomic nervous system may cancel out the above anti-TSH effect. (Australia)

Radiation Effects on Plants

Refer also to abstracts 45649, 45697, 45699, 45702–45705, 45707, 45714, 45717, 45718, 45969, and 47244.

45946 (ANL-7535, pp 125-7) GROWTH PATTERNS AND NEUTRON-GAMMA RADIATION RESPONSE IN SEEDLINGS OF HORDEUM. Frigerio, Norman A.; Johnson, Emil G. Jr.; Seiler, Joann A. (Argonne National Lab., Ill.).

It has been possible to set up barley seedling growth as a radiobiological test system with a precision of the order of ±3%. This, in turn, makes feasible international intercomparisons and studies of the effects of small changes in irradiation parameters, e.g., neutron energy for monoenergetic irradiation. Preliminary results indicate an RBE for 50% seedling height reduction of about 35 for both JANUS fission-plate neutrons and for 663-keV neutrons produced at the monoenergetic facility. Studies are under way for the examination of the neutron energy region 0.03 to 19.2 MeV, where the small size and fixed composition of the seed render dosimetry and interpretation simpler than with mammalian systems. (auth)

45947 (CNM-R-2(Vol.2), pp 826-40) NEUTRON IRRADIATION OF SEEDS IN RESEARCH REACTORS. DEVELOPMENTS OF AN INTERNATIONAL PROGRAMME. Sigurbjoernsson, Bjoern; Konzak, C. F.; Mikaelsen, Knut (International Atomic Energy Agency, Vienna (Austria)); Ahnstroem, G. (Kungliga Tekniska Hogskolan, Stockholm (Sweden)).

Research reactors are now available in a number of countries throughout the world. They were built to be used and their use as a source of neutrons for biological studies, as well as for the practical induction of mutations for plant breeding, is a legitimate one that can be of significance for fundamental research as well as for crop breeding. More knowledge is needed on the effects of neutron irradiation on biological material, not only for the above-mentioned fields, but also for more accurate evaluation of radiation hazards, improved applications in radiotherapy and for space flights. Considerable biological research using plant needs has already been carried out in research reactors all over the world, but progress in this field was slow and obvious discrepancies in the results of experiments carried out in different reactors were reported, reflecting mainly an inadequate determination of the physical parameters that determine the radiation effect and in some cases faulty techniques of exposure of seeds. A group of experts consisting of physicists, chemists as well as biologists, that met recently to discuss neutron seed irradiation, expressed concern by the prevalence of inadequate reporting of dosimetric measurements in neutron studies with seeds. The group felt that this has held back developments of more efficient ways to use neutrons for seed irradiation since consistent results from which to make meaningful comparisons were lacking. (auth)

45948 INCREASED RADIOSENSITIVITY FOLLOWING SIMULTANEOUS ULTRASONIC AND GAMMA-RAY IRRADIATION. Spring, E. (University Central Hospital, Helsinki). Radiology, 93: 175-6(July 1969).

Results are reported from a study that shows that the radiosensitivity of biological material may be increased by simultaneous ultrasonic and γ radiation. Both dry and wet seeds of grass (Lolium italicum) were irradiated and the growth rate, seed weight, and germinative capacity were used as criteria. (C.H.)

45949 RADIATION-INDUCED FREE RADICALS IN EMBRYO AND ENDOSPERM OF BARLEY KERNELS. Ehrenberg, A.; Ehrenberg, L.; Stroem, G. (Stockholm Univ.). Radiat. Bot., 9: 151-8(July 1969).

Embryo and endosperm parts of barley kernels were irradiated at 77°K with ^{60}Co γ-radiation, and ESR spectra recorded at 77°K immediately after irradiation and after heating to 201° or 293°K. In dry embryos (2% H_2O) a narrow signal was mainly obtained, which was relatively insensitive to heating. In dry endosperms (2% H_2O) a broad doublet was recorded which changed into a narrow signal after only 3 min heating to 293°K. Unirradiated embryo material gave a narrow ESR absorption line, the amplitude of which decreased with increasing water content up to 15 percent. No signal was detected in the case of pure endosperm material. The data are in agreement with earlier observations, which show a relationship between narrow-type radicals and biological damage. (auth)

45950 COMPARISON OF THE DEVELOPMENTAL RESPONSE OF DIPLOID AND TETRAPLOID PHALARIS FOLLOWING IRRADIATION OF THE DRY SEED. III. ESTIMATION OF NUMBER OF EMBRYONIC INITIALS TAKING PART IN SPIKE FORMATION. Prasad, A. B.; Godward, M. B. E. (Queen Mary Coll., London). Radiat. Bot., 9: 167-73(July 1969).

Two methods of estimating the number of embryonic initials were used. The first depends on estimating the numbers of mutated sectors in the spike. Chlorophyll mutants were scored in the M_2 generation. In Phalaris canariensis (diploid) the number of mutated sectors (i.e., the number of embryonic initials surviving radiation exposure of 10 kR to form the spike) was 2–3. No such mutants appeared in P. minor (tetraploid) so that this method could not be used. The second method was cytological, the number of embryonic initials in the spike being directly recorded from the nature of meiotic aberrations and their presence or absence in different parts of the spike. The number of cytologically different sectors was found to be the same in both species: 1–3 after 10 kR of filtered and unfiltered X-rays; and 1–2 after 20 kR of unfiltered X-rays. (auth)

45951 DIFFERENTIAL EFFECTS OF SMALL DOSES OF IONIZING RADIATION ON THE GROWTH OF ONION SEED AND BULBLETS AND ON CROP YIELDS. Kahan, R. S. (Soreq Nuclear Research Center, Yavne, Israel). Radiat. Bot., 9: 175-8(July 1969).

Doses of 600 and 1000 rads to onion "sets" (bulblets), applied 8–25 days before planting, reduced crop yields and the number of large onions obtained by about 25 percent and 75 percent respectively. These doses had small effects on onion seeds, either air-dry or wetted to 50 percent moisture content. 300 rad doses on seeds and bulblets did not markedly affect crop yields, but stimulated emergence and seedling growth. (auth)

45952 ACTION OF X-IRRADIATION ON THE DEVELOPMENT AND MICROSTRUCTURAL OF WHEAT SEEDLING CELLS. von Wangenheim, K. H. (Kernforschungsanlage, Juelich, Ger.). Radiat. Bot., 9: 179-93(July 1969). (In German).

After the exposure of wheat-seedlings to X-rays mitotic activity was stopped at relatively low doses (<6.2 kR). Although a somewhat delayed development of the mesophyll cells was noticed at exposures of up to 230 kR, and also for larger seedlings at exposures as high as 660 kR, the development of these cells in general appeared to be normal. The leaf primordia became green and reached a length of 16–63 mm, varying with the size of the irradiated seedlings. The extent of growth of larger seedlings was independent of the supply of organic substances and corresponded to the growth of γ-plants after irradiation of ungerminated karyopses. Dependent upon exposure dose and growth conditions, survival time of the seedlings varied between 20 days and 3 months. The development of cells and the independence of organic nutrition associated with it, were parallel to the decrease in radiosensitivity. Numerous nuclei that showed constrictions and cells with two nuclei suggested that active mitoses were directly affected. These cells also showed normal development and their nuclei were, as those of the controls, subject to a specific change of structure. Up to 6 hr after irradiation with 180 kR, and mainly at higher exposures, characteristic membrane complexes occurred similar to those found during anoxia; this suggests that they are connected with the O_2-metabolism of the cell during and after the irradiation. Higher exposures result in deterioration of the cell structures, which makes fixation for the electron microscope more difficult. On the whole, immediate cell death (in smaller seedlings from 460 kR onwards) generally is apparently not related to changes in cell structures, but becomes obvious by the absence of development of cell organelles.

The investigations suggest that the extranuclear organelles are more resistant than the functional activity of the nucleus, from which it follows that there is a physiologically significant change within the cell after irradiation. (auth)

45953 MORPHOLOGICALLY ABNORMAL CELLS, SOMATIC MUTATIONS, AND LOSS OF REPRODUCTIVE INTEGRITY IN IRRADIATED TRADESCANTIA STAMEN HAIRS. Ichikawa, S.; Sparrow, A. H.; Thompson, K. H. (Brookhaven National Lab., Upton, N. Y.). Radiat. Bot., 9: 195-211(July 1969).

Inflorescences of Tradescantia clone 02, a diploid clone heterozygous for flower color (stamen hair color), were exposed to 69, 180 and 282 R of ^{137}Cs gamma rays at an exposure rate of 23.5 R/min. Stamen hairs were observed for 20 days after irradiation in order to record the numbers of stunted hairs, morphologically abnormal cells and somatic mutation (blue to pink or colorless). The periods of maximum sensitivity varied with exposure and the position of hairs on the stamen. Somatic pink mutations were induced at a rate of 9.11×10^{-4} pink mutant events per meristematic hair cell per R. Colorless mutant events were induced at much higher rates (1.3–3.0 times more colorless events than pink events). Some of the colorless cells, however, were considered to be genotypically pink cells or cells derived secondarily from pink mutant events. The frequencies of the hairs which had suffered complete or partial loss of reproductive integrity (LRI) were determined for each exposure, utilizing induced somatic mutations as markers. Complete LRI and losses greater and less than 50 percent occurred in 0.7, 2.1 and 3.6 percent of stamen hairs, respectively, after 69 R, and 27.9, 27.7 and 15.9 percent of hairs, respectively, after 282 R. It was concluded that the irradiation induced lengthened cell cycle times as well as complete (immediate) and delayed LRI. The lengthened cell cycle time and delayed LRI can explain the occurrence of hairs with partial LRI. The occurrence of morphologically abnormal cells was found to be positively correlated with the LRI but a variable fraction of stunted hairs had no apparent abnormality in the apical cell. (auth)

45954 BORON DEPENDENCE OF THE GENETIC RADIOSENSITIVITY DURING THERMAL NEUTRON IRRADIATION. Ecochard, R.; de Nettancourt, D. (EURATOM–ITAL, Wageningen, Netherlands). Radiat. Bot., 9: 213-19(July 1969).

A modification of the ratio between the two stable isotopes ^{10}B and ^{11}B present in a material exposed to thermal neutrons entails a change in the total dose received, as a consequence of the capture reaction $^{10}B(n,\alpha)^{7}Li$. The genetic effects of this dose change were measured in the F_1 progeny of a cross between two Lycopersicon species which differed for the whole genotype including specific marker genes. Untreated plants, homozygous recessive for these genes, were pollinated with irradiated dry pollen which had been collected from dominant individuals cultivated with nutrient solutions containing respectively 91% and 5% ^{10}B. For eleven criteria the magnitude of the genetic effects (probably deletions) induced by irradiation was found to be modified by the boron treatment in a proportion which ranged from 4 to 65%, depending upon the criterion considered. The mutation frequency at specific nuclear sites was less boron-dependent than the frequency of nonspecific mutations. This finding is in agreement with the hypothesis that boron is preferentially located at some distance from the cell nucleus. (auth)

45955 CYTOLOGICAL CONSEQUENCES OF PROEMBRYO IRRADIATION. Mericle, L. W.; Mericle, R. P. (Michigan State Univ., East Lansing). Radiat. Bot., 9: 269-82(July 1969). (COO–1400-20).

Cytological responses (including effects on embryo size and cell number, changes in mitotic cycle time, and production of chromosome aberrations) exhibited by early and mid-proembryos of barley (Hordeum distichum cv Hannchen) following acute X-irradiation (450 R) were examined in the hope of finding explanations for some of the striking differences in radiosensitivity between these stages (e.g., embryo survival and anomalous organogenesis). In irradiated early proembryos strong diplontic selection appears to operate against cells with gross cytological aberrations which, because of the small number of cells present, makes embryo abortion common. Surviving embryos are mostly those escaping major damage or reconstituted from one or a few undamaged cells. These embryos, therefore, are relatively homogeneous for absence of gross genetic deficiencies during what seems to be the "critical period" for production of organ abnormalities, i.e., just prior to or at the very onset of differentiation stages in embryogeny. Presumably this accounts for organ anomalies being so rare after irradiation of early proembryos. Irradiated mid-proembryos, by contrast, tolerate the continued presence of cells with gross cytological aberrations, and must be, therefore, highly heterogeneous genetically. Intercellular incompatibilities engendered by such heterogeneity during the "critical period" are postulated to be responsible for the high frequency of anomalous organ development associated with mid-proembryo irradiation. Evidently the presence of gross cytological aberrations during actual organ differentiation does not produce abnormality nor does their presence per se result in growth retardation or disturbance of mean mitotic cycle time. Partitioning of cellular components may account for the changes in genetic partiteness manifest during proembryo development. (auth) (UK)

45956 EFFECTS OF ACUTE IONIZING RADIATION ON THE XYLEM FIBERS OF QUERCUS ALBA AND LIQUIDAMBAR STYRACIFLUA. Hamilton, J. R.; Chesser, A. H. (West Virginia Univ., Morgantown. Tariff Commission, Washington, D. C.). Contracts AT(40-1)-2905 and AT(40-1)-3400. Radiat. Bot., 9: 331-9(July 1969).

A quantitative histological examination was conducted on selected cambial derivatives in the stems of two angiospermous species (Liquidambar styraciflua and Quercus alba) which grew in an area surrounding an air-shielded reactor. During a two-year period absorbed doses ranged between background and 35,000 rads for Q. alba and were background and 14,900 rads for L. styraciflua. Radiation greater than 3500 rads had a marked effect on the morphology of cell increments during the time radiation occurred. The libriform fibers produced during irradiation in Q. alba were shorter and possessed thinner walls than the controls. Similar, but less distinct, effects were observed on fiber tracheids in L. styraciflua following dosages of 14,900 rads. Observations made one year subsequent to irradiation indicated that the production of fibers of normal size occurred in trees which returned to an apparently normal gross morphological condition. (auth) (UK)

45957 FINE STRUCTURE OF THE ALGA BRACHIOMONAS SUBMARINA BOHLIN AFTER X- AND γ-IRRADIATION. Underbrink, A. G.; Sparrow, A. H.; Owens, R. A. (Brookhaven National Lab., Upton, N. Y.) Radiat. Bot., 9: 241-50(July 1969).

The green alga, Brachiomonas submarina, was subjected to varying exposures of X- and γ-radiation and the fine structure examined at various postirradiation times. Exposures were in the range of those inhibiting colony formation rather than causing cell lysis. Discernible effects of irradiation were most prominent in cells fixed 5 hr after an exposure of X-rays sufficient to inhibit colony formation 50 percent and in cells examined at daily intervals following an exposure of γ-rays sufficient to inhibit colony formation completely. The cytological effects observed included rupture of the nuclei and nuclear envelopes, presence of cells with lobed nuclei or two nuclear bodies, enlarged vacuoles, swollen and distorted mitochondria with changes in the cristae, an increased number of mitochondria, increased amounts of starch, and possible changes in the chloroplast and dictyosomes. None of these effects was observed in control cells. Nuclear and cytoplasmic damage was observed concurrently at certain postirradiation times but not necessarily in the same cells. Fine structural damage was similar to that which is known to occur in other cell types following exposure to ionizing radiation. The cytoplasmic damage could be sufficient to result in cell death, but until it can be quantified and its physiological significance interpreted and extended to various species, the nucleus should continue to be considered the most probable primary site of radiation damage. (auth) (UK)

45958 INACTIVATION AND KILLING OF THE BLUE-GREEN ALGA ANABAENA DOLIOLUM GROWN ON ULTRAVIOLET-IRRADIATED CULTURE MEDIUM. Srivastava, B. S.; Kumar, H. D. (Univ. of Udaipur, India). Radiat. Bot., 9: 291-5(July 1969).

The spores of Anabaena dolioium were grown on uv-irradiated culture medium. The results obtained indicated that the irradiated medium causes inactivation, reduction in the frequency of sporulation and increased resistance to antibiotics in this alga. Prolonged storage of the irradiated medium, and its exposure to white light immediately after irradiation, rendered it non-toxic. It is concluded that as a result of irradiation of the culture medium some toxic agent is produced which might be responsible for the effects observed. (auth) (UK)

45959 RELATIONSHIP OF GROWTH-RATE AND APICAL SIZE TO DIFFERENCES IN THE RADIATION RESPONSES OF CLOSELY RELATED GENOTYPES OF TOMATOES. de Nettancourt, D.; Devreux, M. (EURATOM–ITAL, Wageningen, Netherlands. CNEN, Rome). Radiat. Bot., 9: 297-311(July 1969).

Attempts were made to study the factors and mechanisms which govern differences in radiosensitivity between diploid species with identical chromosome numbers and similar nuclear volumes. The plant material selected for this purpose consisted of the two tomatoes, Lycopersicum esculentum and L. pimpinellifolium, their reciprocal hybrids and the 8 back-cross lines. Among the six parameters of sensitivity which were studied, nuclear volume, nu-

clear DNA content and mitotic index were investigated only in the two parental species, whereas the analysis of growth-rate and of apical size in embryos and seedlings was extended to all 12 genotypes. The 12 genotypes were exposed to chronic (90 days from the 2nd leaf stage), semi-acute (10 days from the 2nd leaf stage) and acute (dry seed) irradiation. The results obtained indicated that only two biological parameters, growth-rate and apical size in the growing plant, were consistently related to the large genetic differences in radiation response which were observed. The genotypes which were relatively tolerant to chronic irradiation were markedly sensitive to acute or semi-acute treatment. As these genotypes were always characterized by a fast growth-rate and a low number of cells in the apex, the conclusion is reached that the genetic differences in radiation responses essentially result from variations in the dose received per cell cycle and per ontogenetic stage in the case of chronic treatment and from differences in somatic elimination processes after acute and semi-acute irradiation. No genotype differences in radiation responses for seed-set per fruit could be recorded, however, after high dose-rate irradiation of seeds and seedlings. Such a finding is taken as an indication that either a different mechanism of radiosensitivity is controlling the plant response at mature stages or that somatic elimination processes ultimately level off all variations in radio-induced damages. (auth) (UK)

45960 EFFECT OF THE DEVELOPMENTAL STAGE OF GERMINATING WHEAT ON GROWTH AFTER IRRADIATION AT EQUAL SURVIVAL RATES. Reuther, G. (Kernforschungsanlage, Juelich, Ger.). Radiat. Bot., 9: 313-21(July 1969). (In German).

Experiments were performed in order to investigate the influence of the developmental stage of germinating wheat (Triticum aestivum) on its growth, using radiation exposures with LD_{50}. In the premitotic phase of germination, the LD_{50} dose decreased with increasing soaking-time from 35 kR to 2 kR within 24 hr. Using dry weight and number of leaves as parameters, the growth of the surviving wheat plants was found to depend on soaking-time and LD_{50}, with the survival rate being equal. After 2–4 hours' soaking irradiation of dormant seeds with LD_{50} of 35, 25 or 20 kR caused a strong growth inhibition, while the number of leaves increased compared to the control. After 8 hours' soaking (LD_{50} of 10 kR) the radiation-induced growth inhibition decreased to as little as 30 percent, and after the germination period of 10 hr no differences appeared compared to the control at exposures with an LD_{50} of 6 kR. After germination for 12 hr, 4 kR stimulated growth by 40 percent, and after 24 hr 2 kR increased the dry weight by 18 percent compared to the control. Soaking of 10 and more hours also increased the dry weight of those wheat plants which developed only the short-lived primary leaf without further cell divisions and which therefore were considered to have received lethal damage (gamma plants). The phase of increased growth coincided with the beginning of the activation of stored substances. It is concluded that processes of growth that have already been initiated through irradiation are damaged to a lesser degree at this developmental stage than after a shorter soaking-period. A low LD_{50}, due to an increased radiosensitivity, may cause stimulation at certain stages of germination. It was possible to explain the severe growth inhibition after irradiation of dormant seeds, in part, by the changed amino acid content of germinating seeds. With increasing doses the content of neutral amino acids of 3-day-germinated seeds was higher than in non-irradiated or low-irradiated samples. Because of the low content at stimulating exposures, it was concluded that this accumulation resulted from inhibited protein synthesis. (auth) (UK)

45961 INCORPORATION OF LEUCINE IN COTYLEDONS OF CONTROL AND IRRADIATED PEANUT SEEDS (ARACHIS HYPOGAEA, L.). Van Huystee, R. B.; Verma, D. P. S. (Univ. of West Ontario, London, Can.). Radiat. Bot., 9: 323-9(July 1969).

Peanut seeds containing 10 percent moisture were irradiated with 500 kR, stored for 6 weeks and subsequently germinated for three days. The harvested cotyledons were incubated with leucine-^{3}H. Microradioautography of the nonirradiated cotyledons showed that leucine was mainly incorporated in the abaxial side of the cotyledons. In irradiated cotyledons there was less preferential penetration, however, and silver grains were concentrated mainly over intercellular spaces. Sephadex gel filtration confirmed the earlier results that little leucine was incorporated into the various protein fractions and that the proteinaceous macromolecules were broken down to smaller compounds due to irradiation or postirradiation effects. (auth) (UK)

45962 UV-INDUCED FACIES CHANGE IN MICRASTERIAS TORREYI. Kallio, Paavo; Heikkilae, Heli. Oesterr. Bot. Z., 116: 226-43(May 16, 1969).

The effect of uv irradiation on morphogenesis of a unicellular organism was studied. The uv irradiation of M. torreyi was carried out with a Philips TUV-6 lamp (10 min irradiation at a distance of 10 cm). A decrease of the wing number as a result of uv irradiation is described, and the morphology of the aradiate and uniradiate facies of the induced H-clone was analyzed. The theory of morphogenesis in Micrasterias is based on two aspects: a plasmatic framework, the continuity of which depends on its doubling in the interphase stage and on its transfer to the daughter semicell after cytokinesis, controls the number of the main sectorial units and the degree of symmetry; and the nucleus controls the form of these units during the developmental phase of the new semicell. The difference between the 2 morphological groups of the lobes (polar and wing) are discussed. The H-strain of M. torreyi shows that a polar lobe is able to produce a wing unit. (BBB)

45963 INCREASE OF STEROL LEVEL IN YEASTS IRRADIATED DURING CULTURE. Dupuy, P.; Maugenet, J.; Morfaux, J. N. (Station de Technologie Vegetale, Versailles, France). Ann. Technol. Agr., 15: 295-302(1966). (In French).

Several strains of yeasts were compared for their sterol content before and after ^{60}Co γ irradiation. There was no difference in sterol content between Saccharomyces cerevisiae and S. carlsbergensis. Irradiation increased ergosterol synthesis in yeasts when a dose of 100 kRad was given in fractions during culture. The single doses of radiation used varied from 20 to 200 kRad and did not modify synthesis of sterols by the yeasts. Only fractionated irradiation was effective; that is, 40 kRad at the beginning of culture and subsequent 20-kRad doses at 2-hr intervals until a total of 100 kRad had been given. Such irradiation did not modify the chemical nature of synthesized sterols but produced early accumulation of ergosterol and particularly of the esterified fraction. The weight of yeast harvested after 48 hr of culture was the same in irradiated and unirradiated cultures. Irradiation prevented multiplication but not growth of yeast cells and led to the formation of giant cells. Presumably the giant cells did not contain abnormal proportions of lipids. The synthesis of lipids in general and of proteins did not appear to be affected by irradiation. (BBB)

45964 DIFFERENT MECHANISMS OF INACTIVATION DEPENDING ON DOSE AND PHYSIOLOGICAL PARAMETERS. DISCREPANCIES BETWEEN THEORETICAL INTERPRETATION OF DOSE EFFECT CURVES AND BIOLOGICAL FACTS. Fritz-Niggli, Hedi; Blattmann, H. (Univ., Zurich). Biophysik, 6: 46-62(1969). (In German).

The fate of individual cells of the haploid fission yeast Schizosaccharomyces Pombe has been studied after x irradiation with different doses and milieu conditions and in some cases the fate of the descendents has also been followed. Colonies can include early and late inactivated cells (early and late mosaics) while cells can be inactivated in 1, 2, 3, or more cells-stage. At least 10 classes of damage can be distinguished. The proportion of these classes are variable—depending on dose, metabolic conditions and O_2 tension. With low doses early death is frequent, while with high doses late death is increased. In connection with other observations we concluded that with low doses the damage to the nucleus preponderates while with increasing doses the cytoplasmatic damage begins to be important, which can be easily influenced. The analysis of the probability of division after irradiation demonstrated a sharp augmentation of the probability of division-inactivation after the first division. This augmentation of the division-inactivation maintains over the 8th division. The splitting of the survival curves in different individual curves related to damage mechanisms makes the value of interpreting total survival curves doubtful. (auth)

45965 COMPARISON OF THE KILLING EFFECT OF γ RAYS AND THERMAL NEUTRONS. Fujii, Taro (National Inst. of Genetics, Misima, Japan). Annu. Rep. Nat. Inst. Genet. (Engl. Ed.), No. 17, 110-11(1967).

Dry and 48-hr steeped seeds were exposed to thermal neutrons in the reactor of Kyoto University. The lengths of irradiation time were 7 sec minimum and 180 sec maximum at an output of 1 MW. The 7-sec irradiation of dry seeds showed a 19% survival rate, with no survival of plants in other lots. The output of the reactor was diminished to 50 KW in the second experiment and observations repeated in comparison with ^{137}Cs γ-ray effects. The γ-ray irradiation of dry seeds had almost no effect, but slight decrease of survival rate was observed in the 100-kR lot. The decrease of survival rate was marked in wet-seed lots. In the neutron lots, killing effects were severe and no surviving plant was observed after 180-sec irradiation of dry seeds. Higher killing effects in the wet seeds were also seen in the neutron lots, but they might be the result of contaminating γ rays because the environmental modification of radiation effect is very small in high LET radiations, while it is large with sparsely ionizing radiations. These results show that the killing effect of thermal neutrons is very high. (BBB)

45966 RE-ESTABLISHMENT OF CYTOPLASM AND MOTIVE FORCE DURING RECOVERY OF CYCLOSIS IN NITELLA CELLS AFTER IRRADIATION. Gillet, C. (Univ., Namur, Belg.). Protoplasma, 67: 269-78(1969). (In French).

Internodal cells of the freshwater alga Nitella flexilis were irradiated with 50-kV rays at 100 kR/min to total doses of 500 kR. In these experiments on internodal cells, only a fraction of the cellular volume was irradiated. The recovery of the endoplasm (by measurement of the cyclosis in the shielded zone) and the recovery of the ectoplasm where the motive force is generated (by measurement of the cyclosis in the irradiated zone) could be examined separately during the re-establishment of the cytoplasmic streaming. In the shielded zone, the plot (on a semilogarithmic scale) of a typical rate streaming-time curve showed that the speed of the irradiation endoplasm increased according to a second-order equation. With increasing irradiated cellular volume, there was a gradual slowing down of the first processes of restoration and an increase of the definitively altered fraction of the endoplasm. In the irradiated zone, the cytoplasmic streaming stopped completely. About 4 min after treatment, when the chloroplast layer was reorganizing, it exhibited a tendency to flow again. The streaming inclusions moved in a jerky fashion for several minutes. The rate of the protected fraction of the endoplasm increased progressively, demonstrating the recovery of the motive force. An analysis of this process vs time showed that it can be expressed by a second-order equation, as could that of the irradiated endoplasm, but it was faster and the motive force resumed until full recovery (at least during the first hours). These results are discussed in terms of the importance of SH groups, indirect poisoning effect, and kind of lesions, and compared with those observed in completely irradiated cells. (BBB)

Radiation Effects on Microorganisms

Refer also to abstracts 45647, 45688, 45690–45692, 45694, 45696, and 45713.

45967 (ANL-7535, pp 5-6) EFFECTS OF CELL SIZE AND DNA SYNTHESIS ON RADIATION SENSITIVITY OF ESCHERICHIA COLI. Krisch, Robert E.; Finney, Ann; Kubitschek, Herbert E. (Argonne National Lab., Ill.).

Progress of an investigation of the radiosensitivity of Escherichia coli is reported. A single experiment has examined the effects of uv irradiation on E. coli 15THU, which has a generation time of 5 hr. Preliminary results did not indicate a large variation in radiosensitivity over a range of modal cell volumes from 1.0 to 1.4 r^3. (M.M.B.)

45968 (ANL-7535, pp 235-8) EFFECT OF WATER ON THE KINETICS OF THE POSTIRRADIATION OXYGEN EFFECT. Davies, David J. G.; Lobo, Francis X.; Webb, Robert B. (Argonne National Lab., Ill.).

The kinetics of the postirradiation oxygen effect in which damage is dependent on the presence of oxygen after irradiation was studied as a function of water content of spores of Bacillus megaterium. Dose-survival curves were obtained following x irradiation at doses up to about 700 kR in nitrogen followed by oxygen exposure for varying lengths of time. Increasing the water vapor pressure (EVP) increased the rate of development of the post-irradiation oxygen effect. Possible mechanisms for the gradual decrease in magnitude of the postirradiation effect with increasing water content are discussed. (C.O.)

45969 (BARC-392) INVESTIGATIONS ON BASIC MECHANISMS OF RADIOSENSITISATION BY CHEMICALS. II. Singh, B. B.; Srinivasan, V. T.; Bhatt, B. Y.; Joshi, D. S.; Shenoy, M. A.; Bedekar, V. W. (Bhabha Atomic Research Centre, Bombay (India)). 1969. 21p. Dep. CFSTI (U. S. Sales Only).

Iodoacetic acid was found to enhance the γ-radiosensitivity of ATPase and succinoxydase activity in cell membranes isolated from Escherichia coli. The effects of iodoacetic acid, vitamin K5, and the vitamin K analog, 2-methyl-1,4-naphthoquinone on the post-irradiation degradation and synthesis of DNA in E. coli were studied following exposure to 40 kR γ radiation, using ^{3}HTdR as a tracer. No radiosensitizing effects were observed. Iodoacetic acid had no effect on protein synthesis in γ-irradiated cells as measured by ^{14}C-leucine uptake. Vitamin K-5 was found to inhibit mitosis but had no effect on the number of chromosome aberrations in x-irradiated root cells of Vicia faba. Iodoacetic acid enhanced the frequency of anaphase bridges in x-irradiated Vicia cells, but had a post-irradiation protective effect. Vitamin K5 and two analogs, 1,4-naphthoquinone and 2-methyl-1,4-naphthoquinone had a radiosensitizing effect on x-irradiated Staphylococcus aureus. The possible effects of radioinduced free radicals on the radiosensitivity of Staphylococcus aureus are discussed. (C.H.)

45970 ELECTRON-AFFINIC SENSITIZATION. I. A STRUCTURAL BASIS FOR CHEMICAL RADIOSENSITIZERS IN BACTERIA. Adams, G. E.; Cooke, M. S. (Mt. Vernon Hospital, Middlesex, Eng.). Int. J. Radiat. Biol., 15: 457-71(1969).

The bacterium Serratia marcescens was used as a test system for demonstrating the radiosensitizing properties of a class of electron-affinic organic compounds. These include: unsaturated diesters and diketo compounds, mono-, di- and triketohydrindene (indanetrione), derivatives of pyruvic acid, quinones and several miscellaneous compounds. With few exceptions, the sensitization is restricted to anoxic systems. An electron-transfer mechanism, involving interaction of the sensitizer with a charged intermediate produced by direct energy absorption in a target molecule, is proposed as the basis of a model for radiosensitization. (auth)

45971 SENSITIZATION OF BACTERIA TO X-RAY BY NEOARSPHENAMINE. Kligerman, Morton M.; Schulhof, Lee (Yale Univ., New Haven). Radiat. Res., 39: 571-9(Sept. 1969).

Neoarsphenamine (NARS), an organic trivalent arsenical compound, is a sulfhydryl-binding agent whose pharmalogical action in humans is well documented. Because it is a sulfhydryl-binding agent, the possibility that it would sensitize anoxic cells to ionizing radiation was investigated with the idea that such a sensitization could overcome the relative protection that severely hypoxic cells enjoy in certain parts of most human cancers. Micrococcus sodonensis and Escherichia coli K-12 AB1157 were both tested. Though both bacteria were sensitized, the latter is especially interesting because no sensitization occurred when NARS was used in an oxygenated medium. A sensitization factor [defined as the ratio of the slopes, where the slope of the curve refers to the relationship of the surviving fraction (ordinate) to the dose in kilorads (abscessa)] of approximately 2.2 was obtained with AB1157. The effect was reversed by an excess of cysteine added immediately before x-irradiation but was not lost by pre-x-ray washing of cells. Sensitization did not occur unless NARS was present before irradiation. (auth)

45972 ACTIONS OF RADIATIONS ON HOST-VIRUS ONCOGENIC INTERACTION. I. Latarjet, Raymond (Pasteur Inst., Paris). Proc. Res. Inst. Nucl. Med. Biol., No. 10, 168-76(1969).

Effects of radiation on interaction of polyoma virus with host cells are reviewed. The development of specific antigen following infection of cells by the virus and induction of DNA synthesis by the cell are discussed. The production of transforming noninfectious viruses by irradiating polyoma virions is described. Studies on effects of uv and x radiation on infectivity and transformation of virions showed that infectivity was five times as sensitive as transformation. Both functions had the same sensitivity to γ radiation. SV-40 virus was studied with regard to infectivity and synthesis of the nuclear cellular virus specific antigen. It was found that infectivity was more sensitive than synthesis of antigen to uv and x radiation. Studies on the effects of γ radiation on Rous sarcoma virus showed that virions lost the ability to produce viruses but retained the ability to produce tumors. (H.L.W.)

45973 UV-SENSITIVE MUTANT OF ASPERGILLUS RUGULOSUS UNRELATED TO INTERGENIC CROSSING OVER. Tuveson, R. W.; Lennox, J. E. (Univ. of Chicago). Can. J. Genet. Cytol., 10: 50-3(Mar. 1968).

A nuclear gene mutation conferring UV sensitivity in Aspergillus rugulosus has been shown to be uninvolved in the recombination of linked genes and has no effect on ascus and ascospore development. It is possible that this gene is analogous to the well known uvr genes of Escherichia coli. An alternative interpretation of the rec$^-$ mutants in E. coli is presented. (auth)

45974 REPAIR OF DNA AND CHEMICAL RADIOSENSITIVITY: COMPARATIVE EFFECTS OF CAFFEINE AND IODOACETAMIDE ON SURVIVAL AND γ AND UV EFFECTS IN ESCHERICHIA COLI K 12/λ VIR. Mouton, R.; Tremeau, O. (Centre d'Etudes Nucleaires de Saclay, Gif-sur-Yvette, France). Int. J. Radiat. Biol., 15: 369-84(1969). (In French)

Subtoxic concentrations of caffeine, when added after irradiation of the growth medium, inhibit HCR repair enzyme systems of Escherichia coli. Caffeine specifically prevents repair after uv exposure but not after cobalt-60 γ radiation. Iodoacetamide, when substituted for caffeine, is not active at subtoxic concentrations; when given prior to exposure, iodoacetamide shows a definite radiosensitizing action. (H.B.G.)

45975 INVESTIGATIONS OF THE EFFECT OF VACUUM AND RADIATION ON ESCHERICHIA COLI. Buecker, H.; Horneck, G. (Univ., Frankfurt am Main). Biophysik, 6: 69-75(1969). (In German).

Cells of E. coli B/r were exposed to vacuum up to $2 \cdot 10^{-6}$ torr. From these investigations it is assumed that the damaging effect of vacuum mainly depends on the water desorption of the cells. All

effects under consideration, i.e., inactivation, delay of the first cell division, and increase of radiation sensitivity were obtained in the range of about 1 torr. They were scarcely increased by further decompression. Cells that were protected by other bacteria, nutrient media, or crystals were less damaged by vacuum. The radiation sensitivity during vacuum exposure was higher than under control conditions. In vacuum the dose resulting in the same survival fraction was reduced to 1/4 for x rays and to 1/8 for uv respectively. (auth)

45976 THE EFFECTS OF IONIZING RADIATION ON NITRIFICATION IN THE SOIL. Vela, G. R. (North Texas State Univ., Denton). Tex. J. Sci., 20: 315-22(Apr. 25, 1969).

The effect of ^{60}Co γ radiation on the soil microflora that oxidize NH_4^+ to NO_3^- was studied using a system that approximates the native habitat of the bacteria. Doses of 100 kR did not destroy the nitrifying bacteria in various soils. The nitrifying capacity of the soils studied was not great (~1000 colony-forming units/g of soil) and, therefore, the populations of nitrifying bacteria were also not great. Prolonged incubation of the irradiated soils was necessary to reveal the presence of surviving bacteria. Detectable numbers of bacteria, disappearance of substrate (NH_4^+ or NO_2^-), and appearance of metabolites (NO_2^- or NO_3^-) were all delayed as a function of irradiation doses (125 to 1000 kR). The results indicated that the nitrifying bacteria (found in Texas soils) are much more resistant than previously reported. Although the nitrifying power of irradiated soils diminished as a function of radiation dose, it returned to the level observed in unirradiated soils as a function of time. In contrast, the nitrogen-fixing capacity of irradiated soils remained essentially the same as that of unirradiated soils until the azotobacter populations are completely destroyed. Evidently the nitrogen transformations that occur in the soil are disturbed in varied and complex ways by irradiation. Biochemical activities of the soil microflora do not reflect a simple die-or-survive system. The overall biochemical activity of the soil is complex phenomenon encompassing population survival, growth rates, and survival of neighboring bacteria. (BBB)

45977 ACTION SPECTRUM FOR INACTIVATION OF THE INFECTIVITY OF POTATO VIRUS X BY U.V. RADIATION. Kleczkowski, A.; Govier, D. A. (Rothamsted Experimental Station, Herts, Eng.). Photochem. Photobiol., 10: 53-9(July 1969).

Quantum yields for inactivation of infectivity of potato virus X by monochromatic ultraviolet radiation of wavelengths ranging from 230 to 290 nm. were measured with reference to energy absorbed by the whole virus and the virus RNA. The yields depended on the wavelength, but those with reference to energy absorbed by the RNA varied much less (with extreme values of 10^{-3} and 1.9×10^{-3}) than those with reference to whole virus. Consequently the action spectrum for inactivation of a dilute solution of the virus resembled the shape of the absorption spectrum of the RNA, but not closely enough to allow coincidence by adjusting the scales. The amount of photoreactivation increased as the wavelength increased and also as the year progressed from May to July; the extreme values of the photoreactivable sector were 0.43 and 0.86. (auth)

Radiosterilization and Radiopreservation

45978 (NYO-3740-2) PORTABLE CESIUM IRRADIATOR OPERATIONAL REPORTS NO. 1 AND NO. 2. Wootten, Carl B.; Grant, W. B. (Isotopes, Inc., Westwood, N. J.). Mar. 1968. Contract AT(30-1)-3740. 34p. Dep. CFSTI.

A summary is presented of the major activities of the Portable Cesium Irradiator during the initial operations period, which included demonstration programs in Arlington, Massachusetts, from 11 August 1967 through 10 September 1967, and West Chester, Pennsylvania, from 12 September 1967 through 24 September 1967. During the first period, the irradiator was located at New England Farms Packing Company processing tomatoes, oranges, potatoes and bananas, while mushroom processing for five companies was the sole mission in West Chester. The results of these tests are included in this report. A report, NYO-3740-1, describing the preparation of the Portable Cesium Irradiator for operation and the pre-operation work by Isotopes, Inc., during the period 28 June 1966–10 August 1967, has been published. NYO-3740-1 describes the fitting out and source loading of the Irradiator at Brookhaven National Laboratory from early May 1967 through 10 August 1967, at which time it was turned over to Isotopes, Inc. It is intended that future operations of the Portable Cesium Irradiator will be described in forthcoming reports. (auth)

45979 (NYO-3831-1) COST-BENEFIT ANALYSIS OF RADIATION PASTEURIZATION OF MEAT UNDER CENTRALIZED CUTTING CONDITIONS. (Yankelovich (Daniel) Inc., New York). Oct. 1968. Contract AT(30-1)-3831. 202p. Dep. CFSTI.

The objective was to evaluate and estimate the tangible and intangible benefits likely to accrue as a result of commercialized radiation pasteurization of meats including consideration of costs and market acceptability. Problems in the centralization of meat cutting are discussed, as are the interests of the national packing companies versus the large retail chains. The preservation methods of controlled atmosphere, freezing (including cryogenic freezing), radiation pasteurization, and vacuum packaging are compared on the basis of shelf-life extension, cost, and appearance. The cost per pound ascends in the following order: blast freezing, radiation pasteurization, vacuum packaging (individual cuts), controlled atmosphere (bulk), and cryogenic freezing. Irradiation practices are not expected to begin before 1976. A major problem is obtaining the approval of the Food and Drug Administration. The net benefits in cost/pound of meat from centralization of cutting under each of the preservation systems ascend in the following order: cryogenic freezing; Urbain radiation system; controlled atmosphere; vacuum packaging; blast freezing; modified conventional methods. (C.O.)

45980 (ORNL-tr-2216) PRESENT STATUS, FUTURE PROSPECTS, AND POTENTIAL ECONOMIC IMPACT OF COMMERCIAL PRESERVATION OF FOOD BY IRRADIATION. Ortin Sune, N. Translated from Symposium on Applications of Radioisotopes, Madrid, 19–21 June 1967. 11p. Dep. CFSTI.

A panoramic view of the present status, future possibilities, and potential economic impact of food radiosterilization on a commercial scale is given. Those most affected by the commercial radiosterilization of food include: food production sources, food processing industries, food packing industries, manufacturers of irradiation sources and installations, storage and refrigeration installations, food transport industries, and chemical industries. The impact of the commercialization of irradiated food on these industries is discussed. (E.R.B.)

45981 (ORO-669) RADIATION PASTEURIZATION OF GULF SHELLFISH. Annual Report, January 1, 1968–December 31, 1968. Liuzzo, Joseph A. (Louisiana State Univ., Baton Rouge. Dept. of Food Science and Technology). Jan. 30, 1969. Contract AT(40-1)-2951. 25p. Dep. CFSTI.

Organoleptic, chemical, and bacteriological tests during the past five years have shown that low-dose gamma irradiation (^{60}Co) of Gulf shrimp is feasible in extending their iced-storage life. The present project attempts to ascertain the effects of shipping conditions on the quality of irradiated shrimp. Two shipping studies were conducted in cooperation with the Bureau of Commercial Fisheries (B.C.F.) in Gloucester, Massachusetts. Shrimp procured under the supervision of B.C.F. personnel along Florida's Atlantic Coast were flown under ice to B.C.F., washed, deheaded, packaged in double mylar bags and irradiated. Levels of radiation used in the first study were 25, 50, 100, and 200 krads. The 25 krad level was omitted in the second study. Both investigations contained non-irradiated controls. After irradiation, one-half of each treatment was air-shipped to L.S.U. under iced conditions. Both B.C.F. and L.S.U. conducted the following simultaneous iced-storage quality determinations: organoleptic tests—3 times a week; total plate counts—twice a week; and total coliform and fecal coliform counts weekly. Bacteriological and organoleptic results for the two shipments of shrimp indicate that 100 krad was the minimum dose that best extended the keeping qualities of shrimp. The iced-storage life of these shrimp was extended by about 7 days beyond the control. These results were comparable to those obtained by B.C.F. A second phase of this project involved the constant communication with executives of the shellfish industry in an attempt to brief them on the benefits of irradiation. A major effort consisted of a workshop held on the L.S.U. campus where these benefits were discussed. (auth)

45982 SOME EXPERIENCE WITH THE RADIATION STERILIZATION OF DRUGS. Blazek, J.; Opletal, Z.; Seidl, R.; Cerny, P. Cesk. Farm., 17: 228-34(1968). (In Czech).

Radiation sterilization was used for some drug forms—eye collyria, solutions of antibiotics, infusion and anticoagulation solutions, and an ointment base—in order to check the use of γ radiation ^{60}Co as a new method of sterilization. The action of the radiation sterilization was studied from the bacteriological point of view—the effect on the contaminating air microflora and experimental contamination with Bacillus subtilis CCM 2216—the chosen dose of 4 Mrad was found satisfactory for the sterilization effect, and from the chemical point of view—problems of stability and degradation, unfavourable effects were observed mainly in an aqueous medium, caused by radiolysis. The effect on the containers used was also observed; e.g., color of flasks, transfusion bottles, and opaxite crucibles altered as follows: glass into brown and violet, opaxite to grey. The results obtained have considerable importance for practice. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

Metals and Alloys

45983 (ANL–7520(Pt.1)) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SODIUM TECHNOLOGY AND LARGE FAST REACTOR DESIGN, NOVEMBER 7–9, 1968. PART I. SESSIONS ON SODIUM TECHNOLOGY. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 579p. (CONF-681106(Pt.1)). Dep. CFSTI.

Sixty-two articles are included; separate abstracts were prepared for 49. The remaining 13 articles, which were previously abstracted in NSA and are listed in the report number index under CONF-681106(Pt. 1) contain information on: estimation of impurity levels in LMFBR from solubility data, and comparison with impurity behavior in loops; kinetic aspects of corrosion of steels in flowing Na; preliminary corrosion results of Haynes 25 and Type 304 stainless steel with 4 and 12 ppM O in Na at temperatures up to 760°C; cover-gas impurities and their interactions with Na; an integral full-flow vacuum distillation sampling system for use in a high-temperature radioactive Na environment; solubilities of Cu, Ni, and Fe in liquid Na; evaluation of Na-removal methods for fuel elements and piping systems; reactions between oxygen and impurities in Na; O transport in Na; reaction of HCl with liquid Na and a Na–Ba alloy; design of FFTF closed loops; radioisotope transport and deposition in flowing Na; and fission product vaporization from Na systems. (P.C.H.)

For abstracts of individual papers see: 45176–45180, 45235–45240, 45362, 45437, 45438, 45483, 45484, 45489, 45571–45573, 45993–46002, 46032–46035, 46037–46040, 46086, 46119, 46120, 47191–47194, 47215–47217, and 47227.

45984 (ORNL–4396, pp 211-68) MATERIALS DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

Graphite samples were obtained for evaluation. These materials have been characterized by the measurement of several physical properties and have been included in other phases of the MSRE program. Techniques were developed for making several physical property measurements on graphite, including thermal conductivity, electric resistivity, anisotropy by x-ray diffraction, and structure studies by transmission electron microscopy. Several graphites have been irradiated to a fluence of 2.5×10^{22} neutrons/cm^2 (>50 keV) at 715°C. Dimensional measurements indicate that the maximum density and the associated fluence are inversely proportional to the original density, the crystallite growth rates at maximum density are dependent only on the preferred orientation, and grades H337, H364, and AXF show an initial delay before densifying and offer improved dimensional stability. Graphite sealing studies were directed toward optimizing the processing parameters for various graphite substrates. Some sealed AXF samples were irradiated to a maximum fluence of 1.3×10^{22} neutrons/cm^2 (>50 keV). Although the permeabilities increased, one sample had a helium permeability of at least 1.7×10^{-7} cm^2/sec. Other samples have been sealed and are being irradiated. Titanium and carbon additions improved the mechanical properties of a base alloy of Ni–12% Mo–7% Cu. Samples of Ni–12% Mo–7% Cr–0.05% C containing various amounts of titanium were aged for various times at 650 and 760°C. Mechanical property tests showed that changes took place, but these changes were not sufficient to account for the variations noted over this temperature range during irradiation. Electron microscopy revealed that the good properties were associated with a fine MC-type precipitate and that the poorer properties were noted at higher temperatures, where a coarse M_2C-type carbide was formed. The MC-type carbide can be stabilized with higher concentrations of Ti, Hf, Nb, Zr, and Y, and postirradiation creep tests show that good properties result. Corrosion studies continued to affirm the excellent compatibility of Hastelloy N with the lithium beryllium-fluoride salts. A loop constructed of type 304 L stainless steel has a higher, but acceptable, corrosion rate and has operated for over six years without difficulty. The proposed coolant salt, sodium fluoroborate, is more aggressive, but results in thermal convection loops indicate that acceptable corrosion rates are attainable when the water content of the salt is low. A pumped loop of Hastelloy N containing sodium fluoroborate was operated for about 1500 hr. The salt composition has shown some erratic changes in metallic impurities, but operation has proceeded without difficulty. Molybdenum and graphite seem compatible with fuel salts and with bismuth and are potentially useful construction materials for a chemical processing plant for MSBR's. The primary remaining problem is fabrication, since both materials are difficult to join. Techniques have been developed for brazing both materials, but these joining materials may not be compatible with bismuth. The possibility of coating iron-base alloys with molybdenum to prevent temperature-gradient mass transfer of the iron by the bismuth is being investigated. Useful experience has been gained through the use of automatic welding equipment that utilizes the MIG welding process. Several plasma-sprayed bearing surfaces on Hastelloy N have received cursory evaluation. The coatings did not spall during thermal cycling, but several small flaws did develop. (J.R.D.)

45985 (WARD–3791-35) STAINLESS STEEL CLADDING DEVELOPMENT. Quarterly Progress Report for the Period Ending March 31, 1969. Ray, W. E. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). May 1969. Contract AT-(30-1)-3791. 59p. Dep. CFSTI.

Under Task SSAA-110, program status and plans were thoroughly reviewed and updated for the remainder of the fiscal year. Under Task SSAA-210, tensile tests and biaxial stress-rupture tests continued on air-melted material; low-cycle strain fatigue tests were initiated; optical metallographic characterization of PNL tubing and of 15 to 20% cold-worked tubing was completed and compared with tube lots previously examined. A subtask for determining the effects of the degree of cold working on the weldability of Type 316 stainless steel tubing was planned; equipment requirements were identified; facility preparation was initiated; and processing of vacuum-melted material continued. Under Task SSAA-310, samples of air-melted Type 316 stainless steel were micro-characterized. The sensitization studies continued. The sensitized specimens were examined to determine the stability of the matrix alloy, the types of precipitates, and the precipitation kinetics. For comparison, a section of wrought bar of commercial Type 316 stainless steel, solution treated at 2300°F for 1.5 hours, was similarly sensitized and examined. (auth)

45986 METAL FATIGUE: THEORY AND DESIGN. Madayag, Angel F. (ed.). New York, John Wiley and Sons, Inc., 1969. 433p. $15.95.

Information on the theories of material behavior, types of fatigue failure, and the effects of processing and metallurgical factors on fatigue is presented. Chapters are included on fatigue statistical analysis, cumulative damage theories, sonic fatigue, measurement of random loadings, design and manufacturing considerations, and fatigue in helicopter design. (J.R.D.)

45987 REAKTORWERKSTOFFE. TEIL 2. KERAMISCHE UND PULVERMETALLURGISCHE WERKSTOFFE. (Reactor Materials. Part 2. Ceramic and Powder-Metallurgy Materials). Thuemmler, Fritz; Gebhardt, Erich. Teubners Physikalisch-Technische Sammlung. Stuttgart, B. G. Teubner, 1969. 208p. DM 64,-.

Information on the ceramic and powder-metallurgical materials used in reactors is presented. Fuel and breeder materials are first discussed. The preparation and properties of the oxides and carbides of U, Pu, and Th are described. Other ceramic compounds of these elements are also discussed. The preparation and properties of coated particles are described. Dispersion systems were considered with respect to their preparation, properties, and multiplicity of the possible combinations. The radiation effects on ceramic and powder-metallurgy fuel and breeder materials were discussed. The moderators and reflectors—graphite, beryllium compounds, and metal hydrides—and the effects of radiation on them were also described. (J.S.R.)

45988 REACTOR MATERIALS. Volume 12, Number 2. Simons, E. M.; Keller, D. L. (eds.). One of Four Technical Progress Reviews Published for the Division of Technical Information, USAEC. Columbus, Ohio, Battelle Memorial Institute, Summer 1969. 83p. GPO $0.70.

Research progress is reviewed in four sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 45989–45992.

45989 FUEL AND FERTILE MATERIALS. Reactor Mater., 12: 73-88 (Summer 1969).

Results of research are reviewed on U metal and alloys, Pu metal and Pu alloys, Pu compounds, Th and Th alloys, metal–ceramic fuels, oxides, and Th oxides. Information is included on properties and behavior of UC, UN, and US fuels. Information is also included on fuel reactions following loss-of-coolant accidents, fuel alloy corrosion processes, and results of basic studies on irradiation behavior of fuel materials. (J.R.D.)

45990 MODERATOR AND CONTROL MATERIALS. Reactor Mater., 12: 89-94 (Summer 1969).

Results of research and development are reviewed on graphite

preparation and properties, Be metal and Be alloy metallurgy, BeO integrity, properties of Zr hydrides, properties of Nb hydrides, and properties of Ta hydrides. Results of investigations on nuclear poisons incorporating B and/or rare earths are also reviewed. (J.R.D.)

45991 CLADDING AND STRUCTURAL MATERIALS. Reactor Mater., 12: 95-140(Summer 1969).

Results of investigations are reviewed concerning corrosion resistance of various materials, corrosion Zr alloys, Fe alloys, Ni alloys, Co alloys, and refractory metals. Information is included on corrosion of steel by Na and NaK, corrosion of ceramics by Na, corrosive effects of Li, diphenyl, and Cs. Research results on cladding reactions following reactor coolant-loss-accidents are reviewed. Information is also included on radiation effects on structural materials. Properties of Al and Mg alloys are reviewed along with those of stainless steel, Ni alloys, and refractory metals. Information is included on properties of nonfueled refractories, properties of concretes, properties of ceramics, and on diffusion mechanisms. (J.R.D.)

45992 SPECIAL FABRICATION TECHNIQUES. Reactor Mater., 12: 141-54(Summer 1969).

Results of research are reviewed on melting and casting of reactor materials, powder metallurgy materials and methods, coating deposition, explosive forming, welding, and nondestructive testing. (J.R.D.)

Corrosion and Erosion

Refer also to abstracts 45237, 45238, 45438, 45484, 45490, and 46038.

45993 (ANL-7520(Pt.1), pp 93-103) INFLUENCE OF GRAIN SIZE AND WORK HARDENING ON THE CARBURIZATION OF AUSTENITIC STAINLESS STEELS IN LIQUID SODIUM. Valibus, L. (Electricite de France, Chatou. Centre de Recherches et d'Essais).

Samples of Type AISI titanium-stabilized 316 stainless steel were exposed for 1,500 hours in static liquid sodium at 650°C to study the grain-size indices in the core of the sample. Irregular grain size was noted and an increase in weight was noted. An increase of weight, carbon content, and hardness was noted as a function of grain size. Samples of the same type were exposed for 1,500 hours in static liquid sodium at 650°C to study the effects of work hardening on weight and carbon content. The weight and carbon content increase as a function of the strain hardening when graphite was the carbon source. This increase was much less marked in the presence of ferritic steel AISI 430. (J.C.W.)

45994 (ANL-7520(Pt.1), pp 104-9) CARBURIZATION OF AUSTENITIC STAINLESS STEEL BY SODIUM. Kolodney, Morris (United Nuclear Corp., Elmsford, N. Y.).

Measurements of the rates of carburization of austenitic stainless steels in sodium have been reviewed. Models proposed to explain carburization rates have been examined. Emphasis has been placed upon a model in which the assumption is made that carbon from the sodium enters the steel and causes rapid precipitation of a stable carbide, reducing the chromium concentration in the surface. As chromium precipitates, the carbon activity in the stainless steel surface increases until it becomes equal to the carbon activity in the sodium. Thereafter, carbon diffuses into the interior of the steel, precipitating carbide along a front that moves inward. Existing basic data on solubilities, diffusivities, and carbide compositions were employed to predict rates of carburization on the basis of the model and compared with measured values. In addition, the results of short-time carburizations have been correlated with the readings of the United Nuclear Carbon Meter. (auth)

45995 (ANL-7520(Pt.1), pp 131-42) MASS TRANSPORT AND CORROSION OF STAINLESS STEELS IN FLOWING SODIUM SYSTEMS AT 1300°F. Roy, Prodyot; Wozadlo, Gary P.; Comprelli, Frank A. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation).

Extended corrosion studies were made at 1300°F involving the effects of alloy compositions and of heat transfer. A detailed evaluation of the effects of velocity and downstream was also made. The studies were made on Types 304, 316, and 347 stainless steel and Incoloy-800 in flowing Na for periods up to 3000 hr with oxygen levels of less than 10 ppM. The relation between velocity and corrosion rate was found to be approximately linear below 15 fps. With increasing velocity, less than linear dependence was observed, with the deviation from linearity increasing with velocity. An interdependence was observed between the effects of velocity and downstream (Na saturation) on corrosion rate. Corrosion rates measured under comparable conditions were 0.99 mil/yr for Incoloy-800, 0.51 mil/yr for Type 347, 0.44 mil/yr for Type 304, and 0.29 mil/yr for Type 316. The effects of heat transfer on corrosion rate appear to be adequately described as an increase in rate corresponding to an increase in metal surface temperature over the bulk Na temperature. Microstructural changes were observed in all alloys, and appeared to be dependent upon corrosion rate and alloy composition. (P.C.H.)

45996 (ANL-7520(Pt.1), pp 143-50) MASS-TRANSFER PHENOMENA OF THE AUSTENITIC STAINLESS STEELS IN THE LOOP OF SODIUM WITH A HIGH TEMPERATURE AND HIGH FLOW VELOCITY. Furukawa, Kazuo; Nihei, Isao (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment).

The mass transfer analyses of specimens of Types 304 and 316 stainless steel inserted in two test loops of Type 304 stainless steel are presented. The sodium temperature ranged from 380 to 600°C. Sodium flow rates were 4 and 6 l/min; mean flow velocity ranged from 1 to 10 m/sec; sodium purity was measured by plugging temperature of 120°C, corresponding to about 5 ppM O. An exposure time of 1,575 hrs was used. A modified structure layer 5 μ thick was formed at 600°C for Type 304 and 2 μ thick for Type 316 stainless steel with an exposure time of 700 hours. In the cooling region, the existence of Cr_2O_3 was confirmed on the specimen surface. The corrosion weight loss at the highest temperatures increased almost linearly with the Na velocity. Corrosion rates for 600°C and 10 m/sec were 0.3 mg/cm^2/month for Type 304 and 0.4 mg/cm^2/month for Type 316 stainless steel. General aspects of the temperature-gradient mass-transfer mechanism are discussed. (J.C.W.)

45997 (ANL-7520(Pt.1), pp 153-62) CORROSION AND FRETTING CORROSION IN SODIUM. Bogers, A. J.; Chirer, E. G.; Tichler, J. W.; deGee, A. W. J. (Metaalinstituut TNO, Delft (Netherlands)).

Corrosion and mass-transfer tests were carried out at temperatures to 700°C in a dynamic sodium system with a thermal gradient. The behavior of Type 316 stainless steel was studied in two tests lasting 3,000 and 2,500 hours. The results of weight analysis and of metallurgical examination, including metallography and x-ray microanalysis are given. Wear tests under conditions of oscillatory relative motion are described. Tests were performed on Type 316 stainless steel as a potential structural and canning material. Stellite 6B and Tungtec 10112 were tested as potential bearing materials. Steels wear tested included 2¼ Cr-1 Mo, Type 316 stainless steel, and three German austenitic creep-resisting steels indicated as 4988, 4981, and 4961. Differences in wear resistance between austenitic Type 316 stainless steels at 600°C and niobium-stabilized German grades at 650°C were observed. The wear rate of 2¼ Cr-1 Mo steel increased with temperature between 500 and 600°C. The wear rate of surfaced Stellite 6B increased with time and and Tungtec 10112, plasma sprayed and fused on Type 316 stainless steel, had a much higher wear resistance than Stellite 6B. (J.C.W.)

45998 (ANL-7520(Pt.1), pp 163-70) CORROSION STUDIES OF STAINLESS STEEL IN FLOWING SODIUM AT HIGH HEAT FLUX. Hopenfeld, J. (Atomics International, Canoga Park, Calif.).

An experimental technique for the study of corrosion of stainless steel fuel cladding, with heat flux at the surface, in flowing sodium is described. The experimental results indicate that the sodium at the entrance to the heated section is saturated with respect to the corrosion products. This observation together with the well-defined hydrodynamic flow in the test section provides means for testing some of the prevailing hypotheses about the basic mechanism of corrosion in sodium. Because of preferential dissolution of chromium and nickel, an activation technique was developed to measure individual corrosion rates of iron and chromium. After exposure to 1210°F, 20-ft/sec sodium for 387 hr at a heat flux of 0.8×10^6 Btu/ft^2-hr, the relative average losses of iron and chromium over the heated zone were found to be 0.57% ± 0.32% and 2.39% ± 0.45%, respectively. Methods for improving the accuracy of these results and obtaining local measurements instead of average values for the entire heated zone are discussed. Surface roughness measurements show that exposure to sodium under heat-flux conditions for less than 600 hr tends to smooth the surface in the heated zone and roughen the surface in the unheated zone. The available data are not sufficient to provide a complete explanation for these observations. (auth)

45999 (ANL-7520(Pt.1), pp 182-91) CORROSION OF VANADIUM AND VANADIUM-BASE ALLOYS IN SODIUM. Ruther, W. E. (Argonne National Lab., Ill.).

Vanadium and certain stronger vanadium-base alloys (V-5 wt % Cr, V-10 wt % Cr, V-15 wt % Cr-5 wt % Ti, V-15 wt % Ti-7.5 wt % Cr, and V-20 wt.% Ti) were exposed to sodium cold-trapped at two temperatures. The temperatures of exposure varied from 450 to 700°C. Linear rates of weight loss were noted at the higher impurity levels in the sodium (cold trap at ~175°C). Under opti-

mum conditions, very low weight and dimensional changes were noted for vanadium and the vanadium–chromium binary alloys after exposure in sodium cold-trapped at ~110°C. Postexposure chemical analyses indicated that oxygen was the major impurity transferred to the vanadium alloys. Titanium as an alloying additive caused increased impurity pickup and concentrated the impurities in a subsurface band 10 to 100 μm in thickness. The vanadium–chromium binary alloys were the most corrosion resistant at the lower cold-trap temperature, and appeared to offer promise as a reactor fuel cladding. (auth)

46000 (ANL–7520(Pt.1), pp 384–409) WASTAGE OF STEAM-GENERATOR MATERIALS BY SODIUM-WATER REACTIONS. Chamberlain, Harry V.; Coleman, John H.; Kovacic, Evan C.; Shoudy, Albert A. (Atomic Power Development Associates, Inc., Detroit, Mich.).

Tests were performed to determine the dominant parameters for materials wastage during small leaks and to establish means of predicting wastage rates. Test apparatus used ranged from a simple target inside a stagnant pool of sodium to a mockup tube bundle in a dynamic sodium system. The rigs are described. Materials used in dynamic systems included Croloy 2¼ Cr–1 Mo, Incoloy 800, and Types 304 and 321 stainless steels. The injection of a high-velocity jet of water into sodium, such as in the small-leak sodium-water tests, produces a violent chemical reaction with the formation of corrosive reaction products such as sodium hydroxide and sodium oxide, the generation of heat, and the formation of particles and/or jets of the reactants and the products moving at high velocities. Studies were conducted to determine the contribution of corrosion and erosion to the wastage process. Variables affecting material wastage include leak rate, spacing, sodium velocity, type of leak, conditions of sodium and water, configuration in the reaction area, submergence, target coolant, and method of operation. Results are given for stagnant and dynamic systems. Results showed stainless steels are more resistant to wastage than Croloy 2¼ by a factor of 20 to 30 and Incoloy 800 is more resistant to wastage than Croloy 2¼ by a factor of 20 to 30 and Incoloy 800 is more resistant to wastage than Croloy 2¼ by a factor of 30 to 80 Metallurgical examination of wasted areas of Croloy 2¼ indicated that target material which was adjacent to the wasted area and had temperatures up to 2000°F exhibited no evidence of corrosion. The material appeared to have metal loss by an erosion mechanism. (J.C.W.)

46001 (ANL–7520(Pt.1), pp 426–37) WATER CLEANING AND AIR STORAGE EFFECTS ON SODIUM-EXPOSED FUEL CLAD ALLOYS, 304 AND 304L STAINLESS STEEL. Smith, F. A.; Kimont, E. L.; Bohne, L. H. (Argonne National Lab., Ill.).

Specimens of Types 304 and 304L stainless steel were exposed to flowing sodium at 1100°F for seven days. The samples were removed from the loop, allowed to oxidize for one hour, dry steam-cleaned for 15 min, immersed in demineralized water for 45 min, and air-dried. The electric conductivity was measured, then the specimens were subjected to a Strauss reagent test for various times of reagent exposure. Testing data indicate that Type 304L stainless steel was only modestly affected by a single specific exposure to Na. Type 304 exposure to the same Na environment exhibited increased effective electric conductivity values after a given exposure to a Strauss reagent. The next experiment differed from the other by length of air storage. The electric conductivity data are tabulated. Specimens were again exposed for 7 days to 1100°F sodium. Metallographic inspections were made and the results are discussed. Type 304L stainless steel stored for 10 days in humid or dry air underwent small changes in effective electric conductivity. A second air storage and third sodium exposure treatment was performed. Results indicated that Strauss reagent is more aggressive in attack of dry air-stored specimens than in attack of normal air-stored specimens. In a fourth phase of treatment, effective electric conductivity of specimens placed in Na for 7 days at 1100°F and air-stored (normal and dry) for 120 days was measured. Results and comparisons are given. (J.C.W.)

46002 (ANL–7520(Pt.1), pp 481–9) SOME EFFECTS OF HYDROGEN COMPOUNDS IN SODIUM LOOPS. Simpson, J. L.; Dutina, D.; Pohl, L. E. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation).

The elemental impurities in sodium sampled from loops were found to be predominantly hydrogen-containing compounds. Experimental runs were made in which the temperature was varied. Sodium hydroxide and sodium hydride were found in appreciable levels in the plugging compound collector (PCC). The PCC was designed to collect the high-temperature precipitating species. A description of the PCC is given and the experiment is described. The effects of adding or removing hydrogen from the loops were observed. Data are tabulated. (J.C.W.)

46003 (NP-tr-1831) CORROSION OF STEEL BY WATER IN RADIATION CONDITIONS. Rypar, V.; Zajic, V. (Ceskolovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). Translated by B. K. Bowes (Atomic Energy Research Establishment, Harwell, Eng.), from report UJV–1638. 60p. Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 21: 26755.

46004 METALS TO RESIST CORROSION: THE RARER METALS. Sunter, B. J. (South Australian Inst. of Tech., Adelaide). Australas. Corros. Eng., 13: 5-9(June 1969).

The use of the rarer metals in structural and corrosion-resistant applications is discussed. These include beryllium, titanium, tantalum, niobium, zirconium, molybdenum, tungsten, silver, gold, platinum, palladium, rhodium, indium, ruthenium, and osmium. They merit consideration when no other metal will withstand the corrosion conditions, when economical advantages ensue, and when purity of product is of prime importance. (Australia)

46005 APPLICATION OF ZIRCONIUM [FOR CORROSION RESISTANCE] IN CHEMICAL PLANT CONSTRUCTION. Brady, W. R.; Braun, H. Werkst. Korros., 20: 30-5(Jan. 1969). (In German).

Zr is being used increasingly for chemical plant construction where resistance to H_2SO_4, HCl, HNO_3, H_3PO_4, and chlorides is required. The metal also resists alkalis, urea, H_2O_2, and lactic acid well. Zr is best suited for reaction vessels, piping, pump housings, and heat exchangers. The low maintenance cost of plant made from it justify the high price. A heat exchanger designed for operation in 25% H_2SO_4 at 135°C, a stirrer used in 55% Al sulfate and H_2SO_4, and a fractionating column for 65% H_2SO_4 and methanol at 77°C are described. (Metals Abstr.)

46006 THE EFFECT OF HEAT TREATMENT ON THE CORROSION RESISTANT PROPERTIES OF NICKEL-BASE ALLOYS. Svistunova, T. V.; Chermenskaya, N. F.; Runova, Z. K. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 65, 29-34 (1968). (In Russian).

Data are given for the corrosion resistance of the alloys ON70M27F (EP496) containing Ni 70, Mo 27% and V and 0Kh15N65M16V (EP567) containing Cr 15, Ni 65, Mo 16% and W. The optimum quenching regimes for hot-rolled and cold-rolled sheets are established. (Referativnyi Zh.)

46007 THE INITIAL OXIDATION RATE STUDY OF ELECTROPOLISHED CADMIUM SURFACES. Cho, Jong S. J. Korean Inst. Metals, 6: 160-6(Dec. 1968).

The manometric method with a constant-volume-of-reaction cell was used to measure the initial oxidation rate in the temperature range 100 to 195°C and an initial O pressure range of 7 to 8×10^{-1} torr. Two stages of logarithmic initial oxidation rate were found in the temperature range 100 to 180°C. Above this temperature the rate was no longer logarithmic. The influence of surface finish on the oxidation rate is discussed. The empirical and calculated values of oxide thickness at which the second stage begins for electropolished surfaces are less than those of mechanically polished surfaces; these values were 6.3 and 11.86 Å, at 180°C, respectively. (Metals Abstr.)

46008 SEMI-EMPIRICAL ANALYSIS OF THE IGNITION BEHAVIOUR OF PLUTONIUM. Chatfield, E. J. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Nucl. Mater., 32: 218-27(Sept.-Oct. 1969).

Experiments are described in which small cylinders of plutonium were heated slowly to ignition in air and subsequently quenched with nitrogen. The behavior of both the pure metal and the alloy stabilized in the delta phase was studied. The air temperature at which the reaction became self-sustaining was found to be about 500°C for the delta alloy and about 400°C for the pure metal. Measurements were also made of the oxygen concentrations which would support a self-sustaining reaction. A simple theory has been developed, assuming as a first approximation that the oxidation rate of plutonium is directly proportional to the partial pressure of oxygen. This assumption was found to be satisfactory for the delta alloy, the reaction having an activation energy of about 25 kcal/g-atom. The reaction of pure plutonium was more complex and appeared to depend on the previous history of the specimen. The theory also predicts zones outside which plutonium will not undergo a self-sustaining reaction with oxygen. It is shown that massive specimens of delta alloy should not ignite if the oxygen concentration is less than 4×10^{-2} atm. In oxygen concentrations less than this a steady reaction occurs, but in order to maintain the temperature additional heat is required. The ignition behavior of the pure metal varied in an irregular manner from specimen to specimen. However, for any particular specimen predictions based on the theory are in agreement with the observed behavior. The presence of water vapor in amounts up to 16 mg/liter had no observed effect on the ignition behavior. (auth)

46009 SOME STUDIES OF THE AEROSOLS PRODUCED BY THE COMBUSTION OR VAPORIZATION OF PLUTONIUM–ALKALI METAL MIXTURES. I. Chatfield, E. J. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Nucl. Mater., 32: 228-46(Sept.-Oct. 1969).

Experiments are reported in which aerosols were generated by either the combustion or the sudden vaporization of plutonium-sodium mixtures. In the combustion experiments it was found that in general the airborne release was little affected by the presence of the sodium, although in one case a higher release occurred. The properties of the residue were of interest in that after extraction with water a large proportion of the plutonium (1 to 5%) was apparently soluble, a colloidal suspension of fine particles being formed. It was found that even sodium hydroxide or sodium peroxide, if present during the ignition, could induce formation of a large colloidal plutonium fraction after extraction with water. The exploding wire experiments were more reproducible. Here it was found that the aerosol was changed by the presence of the sodium from chains of submicron spheres to a narrow distribution of particles having a mass median diameter of about 1.4 μm. On extraction with water these disintegrated to a stable colloidal suspension in which about 40% of the plutonium was present as particles of diameter less than 50 Å. The sodium-plutonium aerosol was dark brown, and its reactions with water vapor indicate the possibility of a new chemical species of plutonium. It was also found that vaporization of plutonium with sodium hydroxide or sodium peroxide resulted in the formation of limited amounts of the colloidal material after extraction with water. Coagulation experiments indicated that the colloidal material was negatively charged. This result was confirmed by electrophoresis experiments. (auth)

46010 SOME STUDIES OF THE AEROSOLS PRODUCED BY THE COMBUSTION OR VAPORIZATION OF PLUTONIUM–ALKALI METAL MIXTURES. II. Chatfield, E. J. (United Kingdom Atomic Energy Authority, Aldermaston, Eng.). J. Nucl. Mater., 32: 247-67(Sept.-Oct. 1969).

Experiments are reported in which plutonium was vaporized with foreign metals, in particular the alkali metals. The mixed aerosols produced react immediately if a trace of water is present to give solid compounds containing plutonium in the hexavalent state. They decompose on heating and their stability decreases in the series lithium → cesium. They dissolve in water to give positively charged ionic solutions of plutonium VI, even in slightly alkaline solution. They hydrolyze in high pH conditions to give negatively charged plutonium hydroxide colloids, having as much as 50% of the mass as particles less than 50 Å in diameter. Electron diffraction patterns of the compounds are shown and compared with those from the individual metal oxides. Electron micrographs are also shown which illustrate the change in particulate character brought about by the presence of the foreign metal. (auth)

46011 REFRACTORY METALS PROTECTION. Aubry, J.; Roques, B.; Streiff, R. Corros.-Trait., Prot., Finition, 17: No. 2, 61-70(Feb.-Mar. 1969). (In French).

The refractory metals with melting points above 2000°C are discussed; only four (Nb, Ta, Mo, and W) can be employed in practice. Protection systems are reviewed; oxides, metallic or intermetallic compounds, or soft self-feeding coatings are the only practicable ones. All the coatings used in these groups are discussed in detail. (Metals Abstr.)

Preparation and Fabrication

Refer also to abstracts 45447, 45448, 45496, 46006, and 46065.

46012 (RFP-1106) WELDABILITY OF OXYGEN-FREE, BORON-DEOXIDIZED AND DEOXIDIZED LOW PHOSPHORUS COPPER. Brandon, Eldon D. (Dow Chemical Co., Golden, Colo. Rocky Flats Div.). Aug. 15, 1969. Contract AT(29-1)-1106. 13p. Dep. CFSTI.

The weldability of materials and methods of minimizing weld porosity in such materials as oxygen-free (Alloy 102), boron-deoxidized (Alloy 109), and deoxidized low phosphorus (Alloy 120) copper were investigated. Square-butt, fully penetrated welds were made using flat, 0.024- and 0.030-inch thick coupons. In pressurized gas tungsten-arc welding, the variables were chamber pressure, number of welding passes, and type of shielding gas. In the second process, electron-beam welding, only the number of passes were varied. When welded under identical conditions, welds in the boron-deoxidized (Alloy 109) copper contained less porosity. The material was, therefore, considered more weldable. However by the use of proper welding parameters, sound welds were produced in all materials. The variable most affecting weld-metal porosity was related to the number of welding passes made. Particularly with oxygen-free copper, the amount of porosity was reduced by increasing the number of welding passes (up to five). With all materials, the most porous welds were produced using one pass. Four passes were optimum for the boron-deoxidized (BD) copper while the soundness continued to improve with up to five passes for the oxygen-free (OF) and deoxidized low phosphorus (DLP) copper. Argon and helium shielding gases were evaluated for their ability to produce sound welds. For OF copper, helium was the preferred gas. For BD copper at chamber pressures of 20 pounds per square inch gage and below, argon was preferred. For DLP copper, the gases produced approximately equivalent welds. Chamber pressure was a less significant variable. With OF copper, the weldability increased with chamber pressure. Chamber pressure was not significant with either BD or DLP copper. (auth)

46013 VACUUM HOT PRESSING OF TUNGSTEN POWDERS. Ohsawa, Nobuo; Sasaki, Hiroyuki (Tokyo Shibaura Electric Co.). Funtai Oyobi Funmatsuyakin, 16: 140-4(July 1969). (In Japanese).

Tungsten powders were hot-pressed in vacuum at 1100 to 1300°C for 10 min under the pressure of 750 to 875 kg/cm^2. The density of the sintered specimens was 60 to 82% of the theoretical value, indicating that they are still in the initial stage of densification. Without additives, higher density is achieved with fine powders, but the density is not a simple function of the average particle size. In mixed powders, different densification behaviors were observed at lower temperatures and the densification is not affected significantly by the powder parameters. Important factors in densification are powder characteristics, temperature, and pressure in the order stated. (auth) (NSA of Japan)

46014 THE PROPERTIES OF OXIDATION RESISTING TUNGSTEN SINTERED COMPACT. PART 1. Ito, Hiroshi; Furusawa, Masaru. Funtai Oyobi Funmatsuyakin, 16: 145-9(July 1969). (In Japanese).

The effects of chromium content on the oxidation resistivity, transverse rupture strength, and hardness of sintered W compacts were studied. The best oxidation resistivity was obtained with alloys containing 20 wt % chromium, and weight gain at 1200°C was 5 mg/cm^2 for this composition. Transverse rupture strength and hardness decreased with increasing chromium content. (auth) (NSA of Japan)

46015 NEW PROCESS VAPOR DEPOSITS MOST METALS. Mater. Eng., 69: No. 3, 48(Mar. 1969).

A new pyrolytic spray process for chemical deposition has been used to deposit metals including W, Mo, Ti, V, B, and Al, and ceramics such as aluminum oxide, silica and titanium carbide. The advantages of the pyrolytic process over the gaseous process are that deposits can be achieved with compounds that do not have the stability to be vaporized or transported, that undergo fragmenting reactions during transport, or deposition, and that have too low a vapor pressure to be transported. Typical applications include coatings of Ti–TiC for wear resistance, W on Ta for oxidation protection and Al on aircraft fasteners and wire for corrosion protection. (Metals Abstr.)

46016 PAST DEVELOPMENT AND THE PRESENT IMPORTANCE OF POWDER METALLURGY IN THE DEW (Deutsche Edel-stahlwerk). Hotop, Werner. Dew Tech. Ber., 8: 145-6 (Nov. 1968). (In German).

The developments in power metallurgy since DEW's early interest 40 years ago are discussed. Later developments including the setting up of divisions to produce sintered iron and steel, cemented carbides, sintered Mo, Ta, and W, and their alloys are mentioned. (Metals Abstr.)

46017 INTERACTION OF WO_3 AND TiO_2 WITH CARBON. Elyutin, V. P.; Pavlov, Yu. A.; Polyakov, V. P.; Skrobut, Yu. S. Izv. Vyssh. Ucheb. Zaved., Chern. Met., No. 11, 5-10(1968). (In Russian).

The interaction of WO_3 and TiO_2 with C was examined, using a chromatographic method of separation and analysis of O_2, CO, and CO_2. The C used was lampblack. The apparent activation energy in the initial stages of reduction was 29 kcal/mol for WO_3 and 35 kcal/mole for TiO_2, increasing to 49 and 68 kcal/mol, respectively. The effect of temperature on the rate of reduction and the influence of sublimation and dissociation on the process are considered. (Metals Abstr.)

46018 ELECTROSTATIC BONDING OF METALS AND ELECTRICAL INSULATORS. Des. Components Eng., No. 6, 40-1 (Mar. 19, 1969).

Application of a dc potential across a thin binary sandwich of a metal and an insulating material, such as glass, can lead to a mutual bond if the temperature is raised to some point approaching the mp of glass. No fluxes or intermediate phases are involved. This principle is utilized in the Mallovy bonding process in which

it is necessary for the glass and the metal to have similar coefficients of expansion. Bonding is usually achieved with ~1 kV, but 100 V have been used. Si, Ge, Ga, Ta, Carpenter 49, Niromet 44, and Kovan are some of the materials that have been bonded to commercially available matching glass. (Metals Abstr.)

46019 END CLOSURE MEMBER FOR A TUBULAR NUCLEAR-REACTOR FUEL ELEMENT. (to Licentia Patent-Verwaltungs-GmbH). British Patent 1,162,842. Aug. 27, 1969. Priority date Nov. 27, 1965, Germany.

An end closure for a tubular reactor fuel element is described in which the outer and inner sheaths of the end closure member are of different materials having end closure rings which may be connected to one another by extrusion, a screw thread, or other appropriate means. The preferred material for the outer sheath is Zircaloy and for the inner sheath stainless steel or Ni alloy. The fuel may be UO_2. (J.R.D.)

46020 METALWORKING MATERIALS MEMO: MOLYBDENUM. Metalworking, 25: No. 3, 48-9(Mar. 1969).

Recommended materials, tool geometries, and values for depth and width of cut and cutting speed and feed are given for turning, face and end milling, or drilling TZM alloy. Applications for Mo range from exotic applications in aerospace parts, such as nozzles, turbine wheels, and air frames to conventional uses such as die casting dies and cores, hot work tools, welding electrode facings, and electronic components. (Metals Abstr.)

46021 WHAT YOU SHOULD KNOW ABOUT ELECTROCHEMICAL MACHINING. Metalworking, 24: No. 8, 39-42 (Aug. 1968).

Electrochemical machining should be considered in applications involving Waspaloy, Inconel 718, Udimet 700, Ti, Be, machining odd-shaped holes, or cutting complex shapes and workpieces requiring sizing and heat treatment. The ECM process is described along with selection of equipment. Information is also included on selection of power supply, electrolyte systems, types of ECM machines, ECM deburring machines, and special-purpose ECM equipment. (Metals Abstr.)

46022 USE AND PROCESSING OF PURE URANIUM. Schneider, G.; Wolf, A. (Nuclear-Chemie und-Metallurgie GmbH., Wolfgang, Ger.). Metall, 23: 548-53(June 1969). (In German).

The use of pure uranium in reactor physics studies and as shielding constituents is briefly considered. A survey of the primary steps in the processing of pure U is included. Melting and casting, extrusion, hot and cold rolling, drop forging, and cutting operations are discussed. Quality control of these operations is briefly considered. (J.S.R.)

46023 PREPARATION OF METALLIC NIOBIUM AND TANTALUM BY REDUCTION OF THEIR PENTACHLORIDES WITH A LARGE EXCESS OF ZINC. Jangg, G.; Kieffer, R.; Topic, P. Monatsh. Chem., 100: 379-84(1969). (In German).

The pentachlorides are reduced at 520°C with a considerable excess of Zn in an atmosphere of Ar. When the product is cold, the alloy of Zn with Nb or Ta is separated mechanically from the $ZnCl_2$ which contains all non-metallic impurities. Removal of the excess of Zn from the alloys by use of dilute HCl is unsatisfactory for recovery of pure Nb or Ta. If, however, Zn is distilled at 10^{-3} torr from the alloys, the pure metals remain as powders, which may be protected from subsequent oxidation by covering with toluene. The O content of the pure metallic powders is almost 1%. (Metals Abstr.)

46024 IMPROVEMENTS IN OR RELATING TO WELDING THERMOCOUPLES. Downs, Arthur; Maclean, Clive (to United Kingdom Atomic Energy Authority). British Patent 1,162,137. Aug. 20, 1969. Filed Nov. 4, 1965.

Reference is made to thermocouples of the kind comprising wires surrounded by an electrically insulating refractory material in a tubular metal casing, and in particular to an improved method of sealing the ends of such thermocouples. The casing is heated by use of an electron plasma generator, a potential is applied to at least one of the thermocouple wires so as to cause an electric current to flow in a loop including this wire and the plasma, the heating process automatically stopping when current ceases to flow; this happens when the heating process has caused the end of the casing to seal. Means may be provided for maintaining an inert atmosphere, such as argon, in a welding enclosure during the welding operation. Means may also be provided to stop the heating process after a predetermined time even if the current is still flowing. A pump may be incorporated to maintain the gas pressure in the enclosure below atmospheric. (UK)

46025 CHANGE IN THE DENSITY AND STRUCTURE OF PLASMA-DEPOSITED [TUNGSTEN] COATINGS ON MELTING THE SURFACE WITH AN ELECTRON BEAM. Zhudinov, M. I. Elektron. Obrab. Mater., No. 1, 19-20(Jan.-Feb. 1969). (In Russian).

The effect of heat treatment involving the melting of the surface with an electron beam on the structure and properties of plasma-deposited W coatings was studied. Electron-beam melting raised the average density of the coatings from an initial value of 17 to 18 g/cm^3, while the density of the melted regions exceeded 19 g/cm^3. The melting process also had the effect of eliminating a number of impurities resistant to other methods of purification, raised the mechanical strength, and reduced the gas permeability. (Metals Abstr.)

46026 COMPOSITE TUBING SOLVES JOINING PROBLEMS. Steel, 164: No. 18, 48(May 5, 1969).

Composite steel tubing, as, for example, a low-alloy ferritic steel extruded with an austenitic stainless, combines high-temperature strength, corrosion resistance, and good weldability. Bonds are stable and resistant to both mechanical and thermal stresses. One application is in control rod inlets to nuclear reactor vessels. (Metals Abstr.)

46027 MACHINING TUNGSTEN. Bydash, Fred. A. Mod. Mach. Shop, 41: 112-16(May 1969).

Turning of commercially pure wrought W is discussed. Prevention of cracking of parts during moving and chucking is considered along with support of workpiece in machine, use of coolants, tool geometry, and turning speeds when chucking W. Soft chuck jaws or inserts, such as Al, Cu, or Pb must be used. (Metals Abstr.)

46028 WELDING VT-20 TITANIUM ALLOY. Borisova, E. A.; Gruzdeva, L. A.; Loskutov, V. M.; Folomeeva, M. A. Svar. Proizv., No. 3, 28-9(Mar. 1969). (In Russian).

Tests were made on sheet and plate specimens (1, 2, 2.5, 4, 7, 10, and 20 mm thick) of commercial VT-20 Ti alloy which contains Al, Zr, Mo, and V. The joints in 1 and 2.5 mm sheet were made by automatic Ar-arc welding with a non-fusible electrode in one pass without a filler. The joints in 4 to 20 mm plate were made in the same way with manual filler-metal addition. VT-20 alloy is easily Ar-arc welded. The mechanical properties of the welded joints (short and long) and static fatigue strength are practically equal to those of the parent metal. VT-20 welded joints have satisfactorily high thermal stability after extended holding (up to 5000 hr) at temperatures up to 500°C. (Metals Abstr.)

46029 MOLYBDENUM–COPPER–PSEUDO ALLOYS FOR THE RESISTANCE SPOT WELDING OF ALUMINIUM. Tassewa, Sneshana. ZIS (Zentralinst. Schweisstech.)-Mitt., 11: 289-96 (Feb. 1969). (In German).

The preparation, properties, and applications of Mo 67%–Cu 40% powder-metallurgical alloy electrodes for the spot welding of 1 mm thick Al sheet were investigated and compared with the performance of the more common Cu–Cr electrode material. The new material exhibited improved rigidity. After 1000 spot welds, no variation in the working surface of the electrodes could be detected. Further developments of the Mo–Cu electrode are briefly discussed. (Metals Abstr.)

46030 I. ELECTROCHEMISTRY OF MERCURIC SULFIDE COATED ELECTRODES. II. ELECTROCHEMICAL BEHAVIOR OF BORON CARBIDE. Carney, Joseph Harris. Urbana, Ill., Univ. of Illinois, 1968. 122p.

Thesis.

The electrochemically induced exchange of sulfide between solution cations and mercury(II) sulfide $M^{++} + \underline{HgS} + 2e^- \rightleftharpoons \underline{MS} + Hg$ was investigated by linear sweep voltammetry, potential step chronopotentiometry. The cations employed were cadmium(II), lead(II), zinc(II), cobalt(II), and nickel(II). Of the cations investigated, the cadmium(II) exchange approached most closely the simple thermodynamic model of linear sweep voltammetry. In order that the thermodynamic model be applicable, it is required that the activity of the sulfide be determined by the electrode potential according to the Nernst equation. Also, the association of M(II) with $S^=$ to form MS must be rapid with respect to the rate of diffusion of M(II) to the electrode. Potential step experiments produced no definite information concerning the exchange mechanism. The rate constant for the induced exchange of cadmium(II), zinc(II), or cobalt(II) was found to be essentially independent of potential and thus zero order in sulfide concentration. One plausible mechanism to account for the potential independent rate constant is slow exchange. $\underline{HgS} + M^{++} \rightleftharpoons Hg^{++} + \underline{MS}$ slow, $Hg^{++} + 2e^- \rightleftharpoons Hg$ fast. It was found that for concentrations of cadmium(II), lead(II), or zinc(II) greater than 0.1 m$\underline{M}$ the cation adsorbed on the mercury(II) sulfide coated electrode, causes a prewave. The presence of camphor in solution depressed the prewave, but did not affect the diffusion controlled main wave. The cation strychnine · H^+ had the same effect on the cadmium(II) and lead(II) waves, but it obliterated the zinc(II) exchange wave. It was demonstrated that a process involving reduc-

tion or oxidation of the boron carbide surface affects the reversibility of ferricyanide reduction. Metals such as silver, cadmium, lead, or thallium when deposited on the boron carbide surface cannot be completely stripped off electrochemically. Rectifying sites which allow deposition of the metal but not the reverse anodic stripping were proposed. (Diss. Abstr.)

46031 METHOD OF CHLORINATING METALS WITH CARBON TETRACHLORIDE AND CARBON DIOXIDE. Wilhelm, Harley A.; Bergman, Roger M. (to United States Atomic Energy Commission). U. S. Patent 3,460,918. Aug. 12, 1969.

A method is described for the preparation of high-purity metal chlorides, which can be reduced directly to the metal, by passing a gaseous mixture of CO_2 and CCl_4 having a mole ratio of from 0.8:1 to 4:1 over a metal compound while heating the compound to an initial chlorination temperature of 400 to 475°C for 2 to 6 hr. When chlorination is complete at this temperature, the temperature is raised to one or more final chlorination temperatures above 500°C for 1 to 5 hr until the metal compound is completely chlorinated. The process is applicable to the preparation of Ce, Y, Er, Pr, Sm, Nd, Cd, Mg, Pb, and Th. (AEC)

Properties Evaluations

Refer also to abstracts 45236, 45259, 45470, 45487, 45489, 45496, 45587, 46005, 46008, 46082, 47170, 47196, and 47339.

46032 (ANL–7520(Pt.1), pp 18-20) IMPURITY CONSIDERATIONS IN THE NATIONAL PLAN. McKee, J. M. (Argonne National Lab., Ill.).

A brief review is given of objectives and schedules for developing the sodium technology needed to build and operate LMFBR plants in a utility environment, specifically plants with sodium outlet temperatures up to 1200°F. This includes national goals for measuring impurities, determining their effects, and in controlling them, culminating in impurity specifications for LMFBR sodium systems. (P.C.H.)

46033 (ANL–7520(Pt.1), pp 41-54) EFFECT OF HIGH-TEMPERATURE SODIUM ON THE MECHANICAL PROPERTIES OF CANDIDATE ALLOYS FOR THE LMFBR PROGRAM. Kirschler, L. H.; Andrews, R. C. (MSA Research Corp., Evans City, Pa.).

Studies were made on the tensile and creep-rupture properties of uniaxial test specimens for Type 304 and 316 stainless steels in the presence of high-oxygen sodium. Two dynamic Type 316 SS loops were used to perform preliminary unstressed excursions prior to the in-sodium mechanical property tests. Exposures for 500 hr in high-oxygen sodium (50 ppM) at 1200°F and 1400°F were conducted in one loop, while 491- to 760-hr exposures in 1200°F sodium with varying degrees of carbon activity were conducted in the other loop. Subsequently, a third dynamic Type 316 SS loop was used to conduct up to 2000-hr instream creep-rupture tests following the various excursions. The mechanical testing was conducted in 1200°F sodium at a sodium velocity of ~20 ft/sec, an oxide content of the sodium at <10 ppM, and with a >70°F ΔT existing between the specimen test temperature and the coldest sodium-stream temperature. Bar graphs were used to compare previous results on the yield strengths, tensile strengths, and ductilities of Types 304 and 316 SS specimens following the stress-free excursions in helium, oxygen-contaminated sodium, and carbon-contaminated sodium with the same properties of the as-received materials. The data were obtained from room-temperature, 1000, 1200, and 1400°F tensile tests conducted in air. (P.C.H.)

46034 (ANL–7520(Pt.1), pp 74-92) CREEP UNDER HIGH HEAT FLUX AND STRESS-RUPTURE PROPERTIES OF AUSTENITIC STAINLESS STEELS IN ELEVATED-TEMPERATURE SODIUM. Shively, J. H.; Atkins, D. F.; Lee, W. T. (Atomics International, Canoga Park, Calif.).

Stress-rupture tests were performed in static and dynamic sodium with Types 304 and 316 stainless steels. The tests in static sodium were performed on uniaxial and biaxial specimens between 900 and 1400°F. Creep tests were also performed in static sodium with specimens under uniaxial and biaxial stresses. The biaxial stress-rupture tests in dynamic sodium were made using an internal heater that produces a 1×10^6 Btu/ft^2-hr heat flux through the cladding. Results of these tests are intended to identify the significant environmental effects, and quantitatively determine the relative magnitude in support of reactor fuel element design. The results showed that: high-purity static sodium does not influence the biaxial stress-rupture life of stainless steel; the effects of stress state on stress rupture were best compensated for by use of the Von Mises effective stress relation; the stress-rupture behavior of the two stainless steels was essentially the same in the annealed condition; the strengthening benefits of cold work were more permanent in Type 316 than in Type 304 stainless steel; and stress-rupture behavior of Type 304 stainless steel in flowing sodium under a steady heat flux was correlated with the performance in static sodium for the temperature-stress conditions at the peak midwall position. Stress-rupture life of tubes of Type 304 stainless steel in flowing Na under a constant internal pressure and a cyclic heat flux was lower than that predicted using secondary creep data obtained in static sodium. (J.C.W.)

46035 (ANL–7520(Pt.1), pp 110-24) FRICTION AND WEAR IN LIQUID METALS. Barrau, P.; Fontaine, J. P. (Electricite de France, Chatou. Centre de Recherches et d'Essais); Morin, B. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires).

Experimental results are presented for the study made by the French Atomic Energy Commission on the sliding friction of materials in sodium. Data from tests of journal-bearing combinations performed in sodium are tabulated. When one element of the sliding configuration was Type 304, 316, or 321 stainless steel, results were unsatisfactory. Nitrided steel behaved unsatisfactorily. Results are given for material combinations using cobalt-cemented tungsten carbides. Friction coefficients of alloys hardened with cobalt and nickel are given. The friction coefficients of Ni-bonded tungsten carbides on Ni alloy are tabulated in relation to time and temperature. Research of the French Electricity board performed similar tests, but under different conditions and with different materials. Data on testing made in Ar and in Na environments are recorded for various material combinations for the rotating and stationary components. Tests were also performed in a sodium vapor atmosphere after immersion for 15 hr in sodium at 600°C. Quantitative laws of adhesive wear were verified and the volume of material worn out is given by $V = cLx$ where c is a coefficient depending only on the material, L is the contact load, and x the sliding distance. Rapsodie mechanical pumps and bearings of PHENIX fuel-handling transfer-arm mechanisms are briefly discussed. (J.C.W.)

46036 (ANL–7520(Pt.2), pp 121-9) TESTING OF FEASIBILITY OF BALL BEARINGS IN LIQUID SODIUM ENVIRONMENTS. Iwai, S.; Ishii, M. (Mitsubishi Atomic Power Industries, Inc., Omiya (Japan)); Nozawa, M.; Tamura, T.; Abe, Y. (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment); Teramoto, A.; Akiyama, M. (Nippon Seiko Kabushiki Kaisha, Tokyo).

Basic sliding contact tests with ball bearing materials in sodium environments were conducted. Conventional bearing materials and high-temperature wear-resistant materials were chosen for the radial-type bearings. Testing was conducted with liquid sodium at 400°C. It was found that conventional ball bearings could not be used in high-temperature sodium environments. Static tests indicated that the hot hardness and strength of bearing materials decreased with temperature effects to promote the adhesion that increased the rolling friction and caused self-welding due to surface roughness. Better results were obtained with Stellite ball bearings than with steel, stainless steel, or Hastelloy C. (R.C.K.)

46037 (ANL–7520(Pt.1), pp 177-81) DEVELOPMENT OF HIGH-STRENGTH VANADIUM-BASE ALLOYS WITH IMPROVED CORROSION RESISTANCE IN COLD-TRAPPED LIQUID SODIUM. Boehm, Horst; Borgstedt, Hans U. (Kernforschungszentrum, Karlsruhe (West Germany)).

The effects of alloying constituents on the creep and stress rupture behavior of vanadium-base alloys were investigated. The effects of titanium on the tensile properties of V, Nb–Ti–V, and Cr–Ti–V at 650°C are indicated. Strength was enhanced by a low Ti content and the addition of Nb. With the addition of chromium, the corrosion resistance in liquid sodium was improved. The substitution of titanium by zirconium resulted in a lower stress rupture strength. The effects of the chromium content on the corrosion rates of Ti–V and Nb–Ti–V alloys were calculated from weight changes. The effects of Cr additions on the corrosion resistance of V–Zr alloys in sodium are also indicated. (J.C.W.)

46038 (ANL–7520(Pt.1), pp 327-34) PERFORMANCE LIMITS OF MATERIALS FOR SODIUM-HEATED STEAM GENERATORS. Comprelli, F. A.; Krankota, J. L.; Spalaris, C. N. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation).

One of the critical technological requirements which must be met for the sodium-cooled fast reactor concept is the development of a reliable sodium-heated steam generator. The desired operating conditions for the near-term steam generator are such as to permit the use of 2¼ Cr–1 Mo, an alloy with well-established performance in steam and water environments. In addition to familiarity from use in fossil-fired plants, ferritic chromium-molybdenum steels are considered as an attractive possibility for sodium-

cooled systems because they are resistant to stress corrosion, are less expensive pound-for-pound than stainless steel, have higher coefficients of thermal conductivity (20% higher), and lower coefficients of thermal expansion (28% lower). The corrosion performance and mechanical properties of 2¼ Cr–1 Mo steel with regard to extended service in the steam and sodium environment are discussed. Behavior and performance limits related to the near-term needs of the steam generator are interpreted. (auth)

46039 (ANL–7520(Pt.1), pp 418-25) SODIUM EVAPORATION IN AN ARGON FLOW. Van Dievoet, J.; Michel, A.; Lanckman, R. (Societe Belge pour l'Industrie Nucleaire, Brussels).

A general study of fuel conditioning was carried out in Belgium in the framework of the Euratom-Belgium Association for fast breeder reactors. During fuel conditioning, the fuel rods are transferred from the sodium environment to a gas environment. The study was made in an argon atmosphere to remove decay heat from the spent fuel. Some sodium remains on the fuel rod and is entrained in the cooling gas either by drainage or evaporation. Tests were performed to measure the upper limit of the entrained amount of sodium. Rods were extracted in cold stagnant, hot stagnant, and hot circulating argon. There is a strong influence of Na temperature at the time of unloading, but the temperature history has no significant effect on the entrained amount. The surface preparation has a strong effect on the entrained amount. Evaporation is efficient for wall temperature above 350°C and permits practically complete drying above a wall temperature of 450°C. (J.C.W.)

46040 (ANL–7520(Pt.1), pp 455-9) CARBON TRANSPORT IN LIQUID SODIUM. Luner, Charles; Feder, H. M.; Cafasso, F. A. (Argonne National Lab., Ill.).

The mechanisms of carbon transport in liquid sodium were investigated. Studies were made in liquid sodium with ferritic and austenitic alloys. The analyses of total carbon showed that decarburization of the ^{14}C-labelled ferritic crucible occurred whether the Type 316 stainless steel coupon was present or not. An increase in the carbon content of the Type 316 stainless steel coupon was attributed to carbon originating from the ferritic alloy. The concept for carbon transport through liquid sodium is a carbon activity rather than a carbon concentration gradient. (J.C.W.)

46041 (BMI–1866) INVESTIGATION OF THE INITIATION AND EXTENT OF DUCTILE PIPE RUPTURE. Phase I, Final Report. Task 17. Eiber, Robert J.; Maxey, Willard A.; Duffy, Arthur R.; Atterbury, Thomas J. (Battelle Memorial Inst., Columbus, Ohio). July 1969. Contract W-7405-eng-92. 112p. Dep. CFSTI.

Analytical expressions to predict critical flaw sizes in A106B carbon steel and Type 316 stainless steel pipe were formulated and then evaluated with the experimental results obtained from investigation of representative primary-coolant reactor piping materials under simulated reactor conditions. The analytical expressions were found to accurately predict critical flaw sizes. It was determined that the flow stress values can be obtained from tensile tests of the material at the service temperature; this permits critical crack sizes to be predicted in piping on the basis of the vessel geometry and tensile tests of the material. Three modes of failure were identified as leaks, short crack extensions, and ruptures. The conditions governing the failures were also defined, permitting the mode of failure to be predicted. Information was also obtained on the speeds of fractures under simulated reactor conditions and the rupture areas developed. (auth)

46042 (IS-T-316) MODIFIED PULSE TECHNIQUE FOR THE MEASUREMENT OF SPECIFIC HEATS. Blough, Ronald Edward (Ames Lab., Iowa). May 1969. Contract W-7405-eng-82. 63p. Dep. CFSTI.

Thesis.

A modified pulse technique for the measurement of specific heats is described. The technique involves heating a rod specimen to a steady state temperature by passing an ac current through it. The current is cut off and the resulting cooling curve monitored by an infrared microscope. The steady state power, I^2R, supplied to the specimen and the initial rate of temperature change, $(dT/dt)_{t=0}$, as the specimen cools from the steady state temperature are measured. The heat capacity is calculated from the relation $C_p = I^2R/M(dT/dt)_{t=0}$, where M is the mass of the midsection of the specimen across which the power dissipated is I^2R. The uncertainty based on the apparatus and method employed was calculated to be 4.0 to 5.0%. However, experimental results on tantalum and nickel exhibited a larger error with the C_p values 10.0 to 13.0% lower than the literature values. A study of possible sources for systematic error revealed that the measured I^2R power values were approximately 4.0 to 6.0% low because of an error in the measured current. It is felt that with improved instrumentation the systematic errors can be eliminated. (auth)

46043 (MIT–3635-4) SHEAR FRACTURE IN ZIRCONIUM AND ITS ALLOYS. Technical Progress Report. Jensen, John A. Jr.; Backofen, Walter A. (Massachusetts Inst. of Tech., Cambridge). Aug. 1969. Contract AT(30-1)-3635. 6p. Dep. CFSTI.

Results of an investigation of plain-strain deformation in Zircaloy-4 are presented. Basic flow properties and their temperature dependence were also studied by tensile testing. Results are discussed and summarized graphically. (J.R.D.)

46044 (WAPD-Trans–123) HYDRIDE ORIENTATION IN ZIRCALOY TUBES AS A FUNCTION OF DEFORMATION, TEXTURE, AND STRESSES. Schelzke, E. Translated for Bettis Atomic Power Lab., West Mifflin, Pa., from J. Nucl. Mater., 30: 324-36(1969). 26p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 22575.

46045 THE INFLUENCE OF THE DISTRIBUTION OF ALLOYING ELEMENTS BETWEEN PHASES ON WEAR-RESISTANT DEPOSITS. Livshits, L. S.; Grinberg, N. A.; Verenikina, L. E.; Shcherbakova, V. S.; Kurkumelli, E. G. Avtomat. Svarka, No. 12, 26-30(Dec. 1968). (In Russian).

The distribution of alloying elements between phases in Cr–Mn deposits with B and the connection of such a distribution with the mechanical properties of the deposited metal was studied. The carbide-boride distribution was investigated by using a cylindrical specimen 12mm dia × 100 mm long built-up to 20mm dia, over a length of 80mm. The carbides were isolated by electrolytic and chemical methods. Alloying of wear-resistant deposits with B, which is distributed mainly between the carbide and boride phases, results in an increase in hardness of the alloy by the formation of borides and the strengthening of the carbides. The addition of even small quantities of B increases the wear resistance of the alloy considerably. Cr in appreciable quantity alloys the solid solution and toughens it. The addition of B and the formation of borides do not reduce the alloying properties of the solid solution by Cr. Mn strongly alloys the solid solution, hardens it, and results in an increase in grain size which reduces the impact strength. The hard brittle boro-carbide phase distributed in the eutectic around the grains of surplus austenite reduces the impact strength. This can be ascribed to the pronounced embrittlement of the alloy by small additions (0.25 to 0.3%) of B. (Metals Abstr.)

46046 INFLUENCE OF TITANIUM, ALUMINUM, AND BORON ON THE FLUIDITY OF NICKEL ALLOYS. Didyk, B. S.; Babashkin, Yu. Z.; Efimov, V. A. Liteinoe Proizvod., No. 1, 19-20(Jan. 1969). (In Russian).

The influence of additions of Ti, Al, and B on the fluidity of KhN65MVTYu and synthetic alloys based on 80:20 Ni–Cr was investigated. Al and Ti decrease fluidity but also lower the fusion temperature of the alloys. Additions of B up to 0.3% increase the fluidity and improve the structure of KhN65MVTYu alloys. (Metals Abstr.)

46047 INVESTIGATION OF THE SURFACE MIGRATION OF TANTALUM BY MEANS OF THE MUELLER FIELD ION MICROSCOPE. Drandarov, Novak; Bobev, Kaloyan; Kanev, Vasily. Izv. Inst. Elektron., Bulg. Akad. Nauk, 3: 27-38(1967). (In Bulgarian).

The migration processes taking place in the re-arrangement and smoothing of auto-electronic Ta cathodes without an extraneous coating were studied experimentally. The energy of activation of Ta with and without an applied electrical field (3.6 to 4.5 kV) in the movement of Ta atoms along the edge of a single crystal is independent of the field. The coefficient of surface tension is estimated, and the results are interpreted in accordance with the Stranski–Suhrmann method. (Metals Abstr.)

46048 A STUDY OF GAS EVOLUTION FROM MOLYBDENUM AT HIGH TEMPERATURES BY THE VACUUM EXTRACTION METHOD. Ignatov, D. V.; Imenitov, A. V. Fiz. Khim. Obrab. Mater., No. 2, 64-6(Mar.-Apr. 1969). (In Russian).

The kinetics of gas evolution from Mo were studied by a mass-spectro-method (vacuum extraction), using an improved form of Omegatron, at 1000 to 2000°C. The composition of the residual gases in the vacuum surrounding the metal was also determined; these included H_2O, CO, CO_2, H, and CH_4. By analyzing the rate of formation of CO the diffusion of C from the Mo was determined; the mechanism of C diffusion depended considerably on temperature, the activation energy being 10 kcal/mole at 1000 to 1500°C and 30 kcal/mole at higher temperatures. (Metals Abstr.)

46049 COMMENTS ON STRENGTHENING MECHANISMS AND BRITTLENESS IN METALS BY R. W. ARMSTRONG. Wronski, A. S. Ocean Eng., 1: 257-60(Feb. 1969).

A plot of YS vs. the inverse square root of the grain size, for a bcc transition metals at low strain-rate, is presented. The Petch relation is observed in the case of many metals and alloys,

but not for very coarse and very fine grain sizes. Temperature dependence of brittle-fracture and yield stresses is discussed for Mo and W, and the effect of temperature on the tensile properties of polycrystalline Zn at a strain rate of $\sim 2 \times 10^{-4}$ sec^{-1} is shown. The fractional rate of change of YS with temperature is shown for some fcc, hcp, and bcc metals in the 77 to 300°K range. (Metals Abstr.)

46050 LIQUID SEMICONDUCTORS. Enderby, J. E. Engineering, 207: 481-4(Mar. 21, 1969).

Liquid semiconductors are known to exist among Ag–Te, Cu–Te, Tl–Te, and Te–Se alloys but their behavior differs in some unexplained ways from that of solid semiconductors, e.g., they possess negative Hall coefficient but positive thermoelectric power. They retain their semiconductor status at elevated temperature and radiation damage is self-annealing so that they offer possibilities for use in nuclear reactors. They have also possible uses in thermo-electric generators. (Metals Abstr.)

46051 DIFFUSION PROPERTIES OF U–Zr–Nb ALLOYS. Fedorov, G. B.; Smirnov, E. A.; Gusev, V. N. At. Energ. (USSR), 27: 149-50(Aug. 1969). (In Russian).

Diffusion properties of U–Zr–Nb alloys were studied across the section of $C_{Zr} : C_{Nb} = 1 : 1$ (at. %) using radioactive ^{235}U, ^{95}Zr, and ^{95}Nb isotopes. Data obtained showed that uranium alloying with equal amounts (at. %) of Zr and Nb reduced the diffusion mobility and increased the activation diffusion energy of ^{235}U, ^{95}Zr, and ^{95}Nb (with the maximum activation energy and minimum diffusion factor) found in compounds containing from 60 to 70 at. % of alloying materials. It was also postulated that the mechanism for uranium, zirconium, and niobium diffusion was identical to the solid solution replacement mechanism. (R.V.J.)

46052 PROPERTY CHANGES OF GROUP VA METALS CAUSED BY DISSOLVED HYDROGEN, NITROGEN, OXYGEN OR CARBON. 1. VANADIUM-SYSTEMS. Horz, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Metall, 23: 554-9 (June 1969). (In German).

A review is given on the changes in some properties of V by dissolved H, N, O, and C. This review contains both original experimental results as well as data from the literature. The properties considered were resistance, thermoelectric force with respect to copper, magnetic susceptibility, critical temperature of superconductivity, lattice parameters, internal friction, hardness, yield point, tensile strength, expansion, necking, and ductile-brittle transition. (tr-auth)

46053 PROPERTY CHANGES BY PRECIPITATION IN NIOBIUM CONTAINING SMALL AMOUNTS OF OXYGEN AND NITROGEN. Gebhardt, E.; Hoerz, G. (Max-Planck-Institut fuer Metallforschung, Stuttgart). Met. Ital., 61: 289-94(July 1969). (In Italian).

It was found that the terminal solubility of oxygen, nitrogen and mixtures of oxygen and nitrogen in niobium is lowered considerably with decreasing temperature. Thus a principal condition for the process of precipitation is fulfilled in the systems Nb–N, Nb–O, and Nb–O–N. To study such precipitation in supersaturated solid solutions at temperatures between 200 and 1,000°C, resistivity, microhardness, and lattice parameter were determined at different annealing times. Furthermore, microscopic, electron-microscopic, x-ray, and electron diffraction investigations were carried out. In the binary systems Nb–O and Nb–N annealing time isotherms show in general an initial or incubation curve segment, in which the properties are changing negligibly; a middle curve segment in which the properties change considerably; and a final or equilibrium curve segment in which properties change very little. In the system Nb–O microhardness and lattice parameter decrease in one single step, while the resistivity decreases in two steps at annealing temperatures below 600°C and at initial concentrations above 3.6 at.% O. As in the system Nb–N, age hardening effects were not observed during annealing. In the ternary system Nb–O–N, on the contrary, the microhardness isotherms showed two marked maxima. The results could be explained by an interpretation of microstructure and structure. In the system Nb–O—depending on annealing temperature, annealing time, and supersaturation of the solid solutions—various precipitates occur which differ substantially in shape, chemical composition, structure and optical behavior. A platelike, oriented and polarizing suboxide NbO_2 and different shapes of the equilibrium oxide NbO are present. In the system Nb–N only the nitride Nb_2N is precipitated. In the ternary system Nb–O–N the age hardening effects result from the formation of coherent precipitates (zones). At an appropriate temperature and annealing time the same precipitation phases are observed as in the binary systems Nb–O and Nb–N. (auth)

46054 INFLUENCE OF DEFORMATION AND AGING ON THE MECHANICAL PROPERTIES AND ON THE CREEP BEHAVIOR OF TiAl 6 V 4. Breme, J.; Zwicker, U. (Univ., Erlangen, Ger.). Metall, 23: 560-3(June 1969). (In German).

The results of the testing of the mechanical properties of cold worked and variously deposited samples of the alloy TiAl 6 V 4 show that the strength at room temperature can be increased by a preliminary cold deformation up to 72%, without sharp reduction of the viscosity, expansion, and necking. At increased temperature up to 500°C and up to durations of 700 hr, the increased strength is maintained when the deposition temperature does not exceed 500°C. After long periods at 500°C an overlapping of the creep curves are to be expected, which is not the case at a test temperature of 300°C. (tr-auth)

46055 AGING OF NIOBIUM–OXYGEN ALLOYS. Pridantsev, M. V.; Grigorovich, V. K.; Sheftel, E. N. (Inst. of Metallurgy, Moscow). Metalloved. Term. Obrab. Metal., No. 4, 47-50(1969). (In Russian).

An effective increase in the stability of Nb and its alloys can be achieved by alloying Nb with light elements and transition metals such as hafnium, titanium, and zirconium thereby forming thermodynamically stable refractory compounds. At sufficiently high temperatures, the separated enriched phase disassociates and partially develops into a solid solution which, upon subsequent tempering, forms a more dispersed and evenly distributed material. The optimum hardness conditions were investigated for the thermal treatment of Nb-base alloys with 1 at.% Hf or Zr and varying oxygen content. Maximum hardness was reached after tempering to 1700°C and then aging at 900 to 1100°C for 10 to 20 hours. Plastic deformation after annealing increases the process of disassociation. A deformation of 30 to 50% reduces the temperature of optimum aging from 950 to 850°C for alloys of Nb with 1 at.% Zr and O, and from 1100 to 1000°C for Nb alloys with 1 at.% Hf and O. (tr-auth)

46056 THE HIGH-TEMPERATURE PROPERTIES OF MAR-M ALLOY 509. Beltran, A. M.; Sims, C. T.; Wagenheim, N. T. (General Electric Co., Schenectady, N. Y.). J. Metals, 21: No. 9, 39-47(Sept. 1969).

Mar-M alloy 509 is a contemporary Co-base alloy intended for constructional use in a corrosive environment at high temperature. Results of a continuing investigation to evaluate mechanical, process, and physical parameters of this alloy system are presented. The alloy exhibits low room-temperature ductility; heat treatments improve ductility but reduce rupture life at moderate stress and temperature (25 ksi, 1600°F.) Mar-M alloy 509 exhibits good oxidation resistance to 1900°F and excellent hot-corrosion resistance at 1600°F. The flat negative slope of the Mar-M alloy 509 stress-rupture curve also indicates a high degree of phase stability. (auth)

46057 A NEW HEAT- AND HYDROGEN-RESISTANT ECONOMICALLY ALLOYED ALLOY FOR LONG SERVICE AT HIGH TEMPERATURES. Krylova, A. R.; Kozlova, N. N.; Gubanova, L. N.; Ushakov, I. S.; Smirnova, V. A. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 65, 19-23(1968). (In Russian).

The properties of an alloy Kh25N25G6V5MBAR (Cr 25, Ni 25, Mn 6, V 5%, Mo, and Nb) are described. This alloy is intended for long service in media containing high contents of H under pressure at 900°C. The creep values for this alloy are almost the same as those for high-alloy Cr–Ni alloys. The impact strength of the cast specimens was not high but was of the same order as that of Nimocast alloy. The alloy is recommended for long service of up to 10,000 hr at 900°C. (Referativnyi Zh.)

46058 A PHYSICO-TECHNICAL STUDY [OF THE HEAT TREATMENT] OF THE [NIOBIUM–TITANIUM] SUPERCONDUCTING ALLOY 65BT. Gorina, N. B. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 64, 46-55(1968). (In Russian).

An examination of the reaction of the alloy with the gas phase, during heating in air up to 2000°C, allowed determinations to be made of the heating regimes at all stages from the billet to stock. A study of the changes in superconducting properties of the alloy in the final heat treatment made it possible to establish the optimum annealing regime. (Referativnyi Zh.)

46059 NON-MAGNETIC SPRING ALLOYS. Barseg'yan, L. V. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 64, 110-20(1968). (In Russian).

Results are given of a study of dispersion hardened alloys intended for elastic sensitive elements, based on Ni–Cr–Co, Ni–Cr–Nb, and Nb–Ti. The mechanical, elastic, and relaxation properties are given. (Referativnyi Zh.)

46060 THE CREEP PROPERTIES OF Cr–Mo AND Cr–Mo–V TURBINE ALLOYS. Nemeth, Emil. Banyaszat, 101: 260-4 (July 1968). (In Hungarian).

The results of laboratory creep tests indicate that the creep

properties are dependent on the austenite grain size. Heat treatments of the alloys were carried out in such a way that the ratio between the alloying elements in solution and in the form of intermetallic compounds was constant to give optimum creep properties. (Metals Abstr.)

46061 HOT-FORGING DIE MATERIALS, IN PARTICULAR, THOSE OF CAST DIES. Cseh, Miklos; Banki, Tamas. Banyaszat, 101: 509-17(Dec. 1968). (In Hungarian).

The characteristics of die-materials in general and those of some of the best known tool alloys (0.6–0.9 C, Cr–W, Cr–Mo, Cr–Si, and Ni–Cr steels) are reviewed. The usual methods for evaluating these steels are discussed at great length and the most commonly used die-alloys are listed. The recent developments in producing cast-dies and the advantages of these dies compared with more conventional forged-dies are discussed extensively. (Metals Abstr.)

46062 COLUMBIUM (NIOBIUM) AND TANTALUM BUCK HIGH TEMPERATURE LIMITS. Vaccari, John A. Mater. Eng., 69: No. 3, 26-8(Mar. 1969).

Recent research on Nb and Ta alloys with strength, oxidation resistance and fabricability at 2000 to 3500°F includes work on: a new Nb-28/30Hf-13/16W-0/4Ta-1/2Zr-0.07/0.33C alloy which combines good hot strength with oxidation resistance and is intended for turbine applications; mechanical properties and oxidation resistance of Nb-15Hf-5W-2Zr-4Al-4Ti-2N,Nb-15Hf-5W-5Zr and Nb-15.3Ti-13.7Hf-4.1Zr; a Nb-28W-2Hf-0.067C alloy with a high 100-hr stress rupture-to-weight ratio at 2400°F; a Nb-35Hf-15W-5Ti-0.05C forgeable alloy with improved oxidation resistance and strength up to 2000°F; tensile properties of Ta-20Hf-4Al, Ta-30Hf-5W-4Al; a Ta-8W-1Re-1Hf-0.025C alloy with superior creep resistance, good ductility and weldability; oxidation resistance coatings such as slurry type fused silicide coatings for both Nb and Ta; nondestructive tests of coating reliability and studies of diffusion bonding as a means of manufacturing Ta alloy honeycomb composite panels for high temperatures. (Metals Abstr.)

46063 SOLUBILITY OF COPPER IN LIQUID SODIUM. Walker, R. A.; Pratt, J. N. (Univ. of Birmingham, Eng.). J. Nucl. Mater., 32: 340-5(Sept.-Oct. 1969).

The solubility of copper in high-purity, liquid sodium has been measured over the temperature range 495 to 913°K by an equilibration and sampling technique and varies from approximately 1 to 60 ppM by weight. X-ray diffraction analysis has shown that pure copper was in equilibrium with the liquid sodium during the solubility determinations and no indication was found of compound formation in the sodium-copper system. By combining the present results with other recently reported values for the solubility of copper in sodium, the variation of solubility with temperature has been equated to the expression log (ppM Cu) = 5.6362 – 3199.5/T, which is valid over the temperature range 595 to 999°K. The partial molal heat of solution of solid copper in liquid sodium was determined to be 14.6 ± 0.7 kcal/mole. (auth)

46064 DILATOMETRIC BEHAVIOR OF MONOCRYSTALS OF α ZIRCONIUM AND ITS APPLICATION TO THE MEASUREMENT OF MEAN THERMAL EXPANSION COEFFICIENTS ALONG THE PRINCIPAL AXES. Couterne, J. C.; Cizeron, G. (Laboratoire de Metallurgie, Gif-sur-Yvette, France. Laboratoire de Metallurgie, Orsay, France). J. Nucl. Mater., 32: 310-21(Sept.-Oct. 1969). (In French).

The true and mean thermal expansion coefficients of zirconium along the principal crystal axes were determined by dilatometry, using single crystals, the orientation of which had previously been chosen by back reflection Laue photographs. The comparison of these results with those previously obtained using polycrystalline samples with known preferred orientation components has confirmed the sharp diminution of the true thermal expansion coefficient along the a axis from about 400°C; this phenomenon may be connected with a change in the electronic structure of zirconium. Moreover, the presence of grain boundaries appears to constitute a kind of barrier to the free expansion of the metal. This effect may be initiated by a progressive contamination of the boundaries during successive dilatometric cycles; the effect could then be amplified by the pile-up at these boundaries of dislocations created by internal stresses which arise within polycrystalline samples as a consequence of the mechanical anisotropy of the material. (auth)

46065 THE INFLUENCE OF BORON ON THE [WELDABILITY AND] PROPERTIES OF NICKEL-BASE ALLOYS. Medovar, B. I.; Pavlychuk, G. A. Avtomat. Svarka, No. 2, 15-18(Feb. 1969). (In Russian).

Four compositions of alloy steel were tested. Specimens were cut from ingots made by electroslag welding. Heat-treatments were: groups I, II, III; austenitizing at 1100°C for 5 hr in air, aging at 700°C for 16 hr in air; group IV; austenitizing at 1130°C for 5 hr in air, aging at 850°C for 3 hr in air. The strength of group IV high-alloy increased less with B additions than did the low-alloy groups I, II, and III. Boride hardening in all cases was more effective than carbide hardening, and the simultaneous addition of B and C did not noticeably increase the strength in comparison with hardening with B. B increased the long-term strength. Alloys of all groups had good weldability; the occurrence of cracks can be ascribed to the small amount of the primary boride phase formed as the weld crystallizes, as a result of which the crystalline cracks of the boride eutectic are only partially healed. A Ni–Cr–Mo electrode containing 0.3 to 0.6% B was developed, and gave good resistance to the formation of hot cracks. A 'keyboard' specimen which acts as a powerful stress concentrator was used for the crack susceptibility tests. Borland specimens were used for the heat-treatment aging tests. Owing to the absence of cracks, specimens containing 0.45% B were removed from test after 50 hr at aging temperature. B has not only an effect on the heat resistance and weldability, but also on the casting properties at this composition. These results were confirmed by experimental welded cast structures. (Metals Abstr.)

46066 TEMPERATURE DEPENDENCE OF THE ZENER EFFECT IN TANTALUM. Cannelli, Giovanni Bosco (CNR, Rome). Ric. Sci., 38: 1166-76(Dec. 1968).

The possible importance of the Zener effect in some aspects of solid state physics is discussed. The satisfactory agreement between experimental values and theoretical predictions has confirmed that the Zener effect may be characterized, as a first approximation, by a universal function $Z(T/\theta_D$ of the variable T/θ_D. From experimental considerations, tantalum appeared particularly suitable in investigation of the Zener effect because its background dissipation is very low and the coefficient of elastic dissipation Q^{-1}, measured in thin bars vibrating with frequencies around Zener's frequency f_z, gives primarily the dissipation due to the thermo elastic effect. It is remarkable that the Zener effect may give direct information on the temperature dependence of the isothermal elastic modulus and of the thermal diffusion coefficient D. In particular it has been shown that Young's isothermal modulus of tantalum has the same anomalous character as that found for its adiabatic value. (auth)

46067 SLIDING FRICTION OF COPPER ALLOYS IN VACUUM. Jellison, Jane; Predmore, Roamer; Staugaitis, C. L. ASLE (Amer. Soc. Lubric. Eng.) Trans., 12: 171-81(Apr. 1969).

Sliding friction experiments involving Cu and Cu–Be alloy plates in contact with Cu, Cu–Be alloy, steel and Ti alloy sliders were performed in air and vacuum. Microhardness and metallographic examination of plate and slider interface suggests friction and wear by the adhesive friction mechanism with prow formation. Transfer of strain-hardened metal wear debris across the sliding interface was observed. The friction coefficient and the prow size generally increased in vacuum. (Metals Abstr.)

46068 RADIATIVE PROPERTIES OF TANTALUM, MOLYBDENUM, NIOBIUM, GRAPHITE, AND NIOBIUM CARBIDE AT HIGH TEMPERATURES. Khrustalev, B. A.; Rakov, A. M. Heat Transfer–Sov. Res., 1: No. 4, 187-206(July 1969).

The results of an experimental study of radiation properties (integral hemispherical and normal emissivities and the spectral emissivity for $\lambda = 0.65$ and 1 to 5.5 μ, the angular distribution of radiation intensity and the emissivity for $\lambda = 0.365$, 0.460, 0.550, and 0.655 μ) for a number of heat resistant materials are presented. Molybdenum was studied in the temperature range of 900 to 2100°C, measurements in the infrared spectral region ($\lambda = 1$ to 5.5 μ) were done at 1682 and 1825°C. The temperature range for tantalum and niobium was 900 to 2300°C. Tantalum in the infrared spectral region was studied at 1355, 1400, 1599, 1607, and 1763°C, while the temperatures for niobium were 1274, 1606, and 1843°C. The integral normal emissivity of reactor graphite was determined in the temperature range of 900 to 2600°C, electrographite [graphite produced in an electric furnace] was studied in the 900 to 2000°C range, with the range for niobium carbide being 900 to 2900°C. The spectral emissivity in the infrared region for reactor graphite was measured at 1584 and 2040°C, for electrographite at 1188°C, and for niobium carbide at 1520 and 2217°C. (auth)

46069 REACTIONS IN THORIATED TUNGSTEN AND THORIATED MOLYBDENUM. Katlinskii, V. M. Sb. Tr. Vses. Zaoch. Politekh. Inst., No. 39, 67-74(1967). (In Russian).

Tungsten with up to 2% thorium dioxide is widely used for making cathodes for medium-power generating lamps. The addition of thorium dioxide increases the thermionic emission; this is explained by the formation of a nonatomic layer of metallic thorium on the surface of the tungsten. The reduction of thorium by thermodynamic methods is reviewed. The kinetic calculations show that, even in the most favorable case (reduction by tungsten

at 3400°K) three or four days are required for completion of the reaction. In thoriated tungsten obtained by the method used for metalloceramics, there can be metallic thorium in an amount not more than 0.45% of the quantity which was added in the form of thorium dioxide. At 2900°K, metallic thorium, which does not suffice even for the creation of a single monolayer, can be formed in thoriated tungsten. Nevertheless, the thermionic emission of thoriated tungsten and molybdenum is sufficiently high, which led to the conclusion that, while tungsten and molybdenum cannot act as reducing agents for thorium dioxide, the reduction takes place by the direct disproportionation of thorium dioxide. (JPRS)

46070 MEASUREMENTS OF HALL CONSTANT IN Nb–Zr SYSTEMS. Korsunskii, M. I.; Genkin, Ya. E.; Larin, M. P. (Inst. of Nuclear Physics, Alma-Ata, USSR). pp 25-8 of Voprosy Obshchei i Prikladnoi Fiziki. Alma-Ata, USSR, Izdatel'stvo Nauka Kazakhskoi SSR, 1969. (In Russian).

From 1st Kazakh Republic Conference on General and Applied Physics, Alma-Ata, USSR. See CONF-670556.

Measurements of Hall effects in specimens of Nb–Zr alloys showed that in the concentrations examined (0 to 52% Zr) the Hall constant was positive. The maximum value of the Hall constant was found at concentrations between 12 and 35% Zr. (R.V.J.)

46071 THE INFLUENCE OF ANNEALING ATMOSPHERE AND TEMPERATURE ON MECHANICAL PROPERTIES OF Mo WIRE. Ermatov, S. E.; Turdybekov, I. T.; Vakhabov, M. V.; Omarov, A. O. (Inst. of Nuclear Physics, Alma-Ata, USSR). pp 37-9 of Voprosy Obshchei i Prikladnoi Fiziki. Alma-Ata, USSR, Izdatel'stvo Nauka Kazakhskoi SSR, 1969. (In Russian).

From 1st Kazakh Republic Conference on General and Applied Physics, Alma-Ata, USSR. See CONF-670556.

Optimum conditions were found for thermal treatment of Mo prepared by powder metallurgy. Specimens of Mo wire (99 and 97%) 60 μ in diameter were annealed in hydrogen and vacuum environments at 800 to 1200°C. At 1200°C, the ductility increased 8% but strength decreased. Maximum ductility was reached at 900°C and pressure of 10^{-2} torr. (R.V.J.)

46072 A STUDY OF A NEW HEAT-RESISTANT CHROMIUM–NICKEL ALLOY OF TYPE M15V3B2R1. Nekhendzi, Yu. A.; Fu, Khen-chzhi; Khoroshailov, V. G. Tr. Leningrad. Politekh. Inst., No. 295, 73-80(1968). (In Russian).

A study was made of Ni alloys strengthened with Mo, W, and Nb and not containing film-forming elements (Ti and Al) in contrast to the present heat-resistant alloys. Test methods used to study the separate and combined effects of Mo (3, 6, 9, 15%), W (3, 10, 15%), and Nb (2, 5, 10%) on a Ni–Cr alloy containing Cr 16 and C < 0.1% are described. The effects of further supplementary alloying with B, Ce, C, Co, and Fe were studied. As a result a new alloy of the M15V3B2R1 type is proposed, which contains Mo 15, W 3, Nb 2, B 0.01% and is strengthened on aging by a complex intermetallide. This alloy has satisfactory properties at room temperature and at 750 to 800°C and is recommended for castings to replace the corresponding Nimonics, for operation in the range 750 to 800°C. Thin-walled castings of the turbine blade type can be obtained with the normal methods of melting and casting in air. (Referativyni Zh.)

Structure and Phase Studies

Refer also to abstracts 45496 and 46047.

46073 (COO-1198-661) INFLUENCE OF TRACE IMPURITIES ON DEFECT BEHAVIOR. Koehler, J. S. (Illinois Univ., Urbana). Aug. 1969. Contract AT(11-1)-1198. 16p. (CONF-691007-1). Dep. CFSTI.

From Corrosion by Liquid Metals Conference, Philadelphia, Pa.

Experiments which demonstrate that impurities nucleate clusters of interstitials and clusters of vacancies in gold are described. The experiments utilize specimens with total impurity concentration between 10^{-6} and 10^{-4} atom fraction. It is shown that the impurities influence damage production during electron irradiation at 80°K, alter annealing after quenching and after electron irradiation and influence the apparent activation energy observed in certain quenching and deformation experiments. (auth)

46074 THE ALLOYING BEHAVIOR OF ZIRCONIUM. CHARACTERISTIC PRINCIPLES OF THE CONSTITUTION OF BINARY PHASE DIAGRAMS. Borchers, H.; Saur, G.; Lehmann, W. (Technische Hochschule, Munich). Metall, 23: 543-8(June 1969). (In German).

All of the Zr alloys listed in the literature were classified in the form of the periodic system. With the help of the regularities observed in the construction of the table and with consideration of the alloying theories, a method was shown which makes it possible to make quickly and easily an assumption on the structure of as yet uninvestigated phase diagrams of Zr. The expansion of the mixed crystal range and the number of intermetallic compounds to be expected, predicted by the study, was of special interest. (tr-auth)

46075 INTERMETALLIC 2-17 STOICHIOMETRY: THE CRYSTAL STRUCTURE OF Th_2Fe_{17} AND Th_2Co_{17}. Johnson, Quintin; Smith, Gordon S.; Wood, David H. (Univ. of California, Livermore). Acta Crystallogr., Sect. B, 25: 464-9(1969).

The monoclinic structure reported for Th_2Fe_{17} and Th_2Co_{17} has been found to be in error. The correct structure is rhombohedral, $R\bar{3}m$, with hexagonal cell constants of a = 8.565, c = 12.469 Å for Th_2Fe_{17} and a = 8.438, c = 12.254 Å for Th_2Co_{17}. Calculated densities are 8.885 and 9.661 gcm^{-3} for the iron and cobalt compounds, respectively. These compounds were found to be isostructural with Th_2Zn_{17}. Although literature surveys cite at least five A_2B_{17} structure types (Th_2Fe_{17}, Th_2Ni_{17}, Th_2Zn_{17}, U_2Zn_{17}, and Nb_2Be_{17}), only the Th_2Zn_{17} structure type is both unique and compositionally correct. A remarkable feature of the Th_2Zn_{17} structure type is the constancy of the c/a ratio. This ratio has been found to be 1.46 ±0.01 for over 40 compounds with the Th_2Zn_{17} structure. (auth)

46076 PHASE RELATIONS IN THE PLUTONIUM–LEAD SYSTEM. Wood, D. H.; Cramer, E. M.; Wallace, P. L.; Ramsey, W. J. (Univ. of California, Livermore). J. Nucl. Mater., 32: 193-207(Sept.-Oct. 1969).

An extensive investigation of the plutonium-lead phase diagram has been conducted using differential thermal analysis, metallography, x-ray diffraction, and electron microprobe analysis. The alloys were found to be generally much higher melting than previously reported in the literature. Six intermetallic phases were observed in the work reported. These have been identified as Pu_3Pb, Pu_2Pb_3, Pu_5Pb_4, Pu_4Pb_5, $PuPb_2$, and $PuPb_3$, although Pu_4Pb_5 appears to be of a new structure type and the designation is therefore tentative. A comparison with the literature concerning compounds of group 4A elements with plutonium is made. Incidental metallographic experiments with uranium-lead and plutonium-tin alloys are described. The results of this work are found to vary from those in the literature concerning plutonium-lead and plutonium-tin alloys. (auth)

46077 ELECTRON PROBE MICROANALYSIS OF THE PLUTONIUM–LEAD ALLOY SYSTEM. Nickerson, R. F. (Univ. of California, Livermore). J. Nucl. Mater., 32: 208-17(Sept.-Oct. 1969).

The electron probe microanalyzer was used to determine the chemical compositions of the many phases that exist in the plutonium-lead binary alloy system. Probe analysis helped to identify these phases as having the following stoichiometries: Pu_3Pb, Pu_2Pb_3, Pu_5Pb_4, Pu_4Pb_5, $PuPb_2$, and $PuPb_3$. The applicability of the Ziebold–Ogilvie empirical method for quantitative analysis of this system is described and its applicability to Pb-Pu alloys, and similar systems for which no standards are available is shown. (auth)

46078 ISOTHERMAL MARTENSITIC $\beta \rightarrow \alpha'$ TRANSFORMATION OF U–0.45 WT PERCENT Mo ALLOY AT LOW TEMPERATURE. Mihajlovic, A.; Mance, A. (Boris Kidric Inst. of Nuclear Sciences, Belgrade). J. Nucl. Mater., 32: 357-61(Sept.-Oct. 1969).

The isothermal $\beta \rightarrow \alpha'$ transformation of U–0.45 wt % Mo was investigated at −200°C. Results indicate that at −200°C the isothermal $\beta \rightarrow \alpha'$ martensitic reaction is not stopped but greatly slowed down. At this temperature the isothermal $\beta \rightarrow \alpha'$ reaction produces exclusively α' plates, which show that their nucleation and growth are controlled by shear. The plates grow in two directions. The growth of the α' martensite of the feathery type is stopped at −200°C. It seems that for the feathery grains the nucleation is diffusion-controlled and growth shear-controlled. (J.R.D.)

46079 UNIT-CELL CONSTANTS OF SOME $PuNi_3$-TYPE COMPOUNDS. Dwight, A. E. (Argonne National Lab., Ill.). Acta Crystallogr., Sect. B, 24: 1395-6(1968).

Crystal structure data, including unit-cell constants and observed intensities obtained from powder patterns, are presented for UCo_3 and other $PuNi_3$-type compounds. (auth)(Denmark)

46080 METALLOGRAPHIC EXAMINATION OF THE INITIAL STAGES OF GAMMA PHASE TRANSFORMATION IN A URANIUM–NIOBIUM ALLOY. Duric, Branko Lj.; Mikhajlovic, Aleksandar Z. Glas. Hem. Drus., Beograd, 32: 357-64(1967). (In Serbian).

Samples of a U–1.85 at.% Nb alloy were subjected to isothermal heat-treatment at 640 to 680°C and the initial stages of the γ phase transformation thus engendered were studied by metallographic analysis. The transformation was in many respects analogous to the decomposition of austenite in steels (hypo-eutectoid), involving the formation of primary Widmanstätten structures near the grain boundaries at the lower end of the temperature range studied and

secondary Widmanstätten structures at the higher end. (Metals Abstr.)

46081 EFFECT OF COOLING RATE FROM THE GAMMA AND BETA REGIONS ON THE SIZE AND DISTRIBUTION OF THE SECONDARY PHASES IN LOW-ALLOY URANIUM. Jovanovic, Milan T. Glas. Hem. Drus., Beograd, 32: 505-14(1967). (In Serbian).

The phase composition of pure U and U containing 0.1% Al, furnance- or vacuum-cooled from the β and γ regions was studied in the electron microscope and the effect of cooling rate on the size and distribution of the secondary phases was determined. In general the more slowly cooled material had a finer microstructure. By adjusting the cooling rate to an optimum value, material with excellent physical and mechanical properties was produced. (Metals Abstr.)

46082 AMPLITUDE-DEPENDENT INTERNAL FRICTION IN ZINC BINARY ALLOYS. Bortolotti, Alberto; Passari, Luigi (Univ., Ferrara, Italy). Ric. Sci., 38: 1143-8(Dec. 1968).

Experimental data show that the effects of Cd and Ag impurities on the amplitude-dependent internal friction of Zn are very different. It is difficult to explain this behavior with elastic interaction only. The partial disagreement found between the experimental data and the deductions of Granato and Lücke could be attributed either to the thermal activation or to a Wertman and Salkowitz type mechanism. (auth)

46083 CRITICAL TEMPERATURES AND THE NATURE OF THE CRYSTALLIZATION OF HEAT-RESISTANT ALLOYS OF THE NIMONIC TYPE AND OF SOME NON-FILM FORMING ALLOYS STRENGTHENED WITH NIOBIUM. Efimova, M. N. Tr. Leningrad. Politekh. Inst., No. 295, 81-9(1968). (In Russian).

A study was made of the effects of the alloying elements Cr, Nb, Co, Al, Mo, and W on the critical temperature and the solidification interval of Ni-base alloys. The additive principle could not be used to estimate the simultaneous action of several alloying elements on the liquidus temperature. A formula was introduced for the determination of the liquidus temperature from the composition for a certain group of alloys. With an increase in superheat the solidification was more directional and, in some alloys, high superheat above the liquidus resulted in a more refined structure. (Referativnyi Zh.)

46084 DIFFERENTIAL ENTHALPY STUDY OF THE α-β TRANSFORMATION IN PLUTONIUM. Prunier, C.; Radenac, A.; Roux, C.; Rapin, M. (Commissariat a l'Energie Atomique, Paris). Scr. Met., 3: 381-4(June 1969). (In French).

A simplified conduction calorimeter was used to measure the transformation heats of the $\alpha \rightarrow \beta$ and $\beta \rightarrow \alpha$ transformations of annealed and unannealed Pu samples. The endothermal $\alpha \rightarrow \beta$ transformation began at 119 + 2°C and had a value $L_t = 844 \pm 10$ cal/mole for the annealed samples. For the unannealed samples the transformation began at 120 ± 2°C and the heat of transformation was 849 ± 15 cal/mole. The $\beta \rightarrow \alpha$ transformation in the annealed sample had a heat of transformation of −821 ± 25 cal/mole, for a transformation rate of 97%. In the non-annealed samples the thermograms obtained were very irregular, and an enthalpic analysis showed that the transformation was not complete. (J.S.R.)

46085 EFFECTS OF LASER IRRADIATION ON STRUCTURAL CHANGES IN MOLYBDENUM MONOCRYSTALS. Basharov, R.; Ermatov, S. E.; Kaipov, D. K.; Trekhov, E. S.; Turdybekov, I. T. (Inst. of Nuclear Physics, Alma-Ata, USSR). pp 28-30 of Voprosy Obshchei i Prikladnoi Fiziki. Alma-Ata, USSR, Izdatel'stvo Nauka Kazakhskoi SSR, 1969. (In Russian).

From 1st Kazakh Republic Conference on General and Applied Physics, Alma-Ata, USSR. See CONF-670556.

Metallographic studies revealed cracks on the surface of molybdenum monocrystals irradiated by a laser beam of specific energy of 3×10^4 cal/cm² sec. For irradiation with a laser beam of 10^5 cal/cm² sec, the damaged zone separated from the melted mass, revealing deformation lines all around the zone. (R.V.J.)

Radiation Effects

Refer also to abstracts 47235 and 47342.

46086 (ANL-7520(Pt.1), pp 55-73) INFLUENCE OF SODIUM AND OF IRRADIATION ON THE HIGH-TEMPERATURE CREEP BEHAVIOR OF CERTAIN STAINLESS STEELS. Andre, J. P. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Beaufrere, J.; Valibus, L. (Electricite de France, Chatou. Centre de Recherches et d'Essais); Weisz, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Tests were made on the creep behavior of Type AISI 316 stainless steel and Hastelloy X in the presence of air, argon, dynamic and static sodium at 700°C. Rupture time and elongation were slightly greater in static Na than in Ar, air, and dynamic Na. Secondary creep rate was lowest in dynamic sodium. A surface layer developed in static Na, an oxide layer developed in Ar, and a finite layer developed in dynamic Na. Irradiation testing of Type 316 stainless steel was also performed. Irradiation decreased life duration and ductility at rupture due to radiation effects on the intergranular rupture process. Stress, rupture time, and minimum creep rate data are tabulated for tests on Type 316 stainless steel before, during, and after irradiation for fast and thermal neutron dosages. For a test temperature of 700°C in the range of stresses studied and for fast fluxes of 10^{13} and 10^{14} n/cm²/sec, the properties were basically identical. Irradiation did not change the strength but diminished the ductility and rupture time. This decrease increased with the flux. (J.C.W.)

46087 (BNWL-1128) IRRADIATION SPECTRAL INFLUENCE ON DAMAGE CORRELATION. Russcher, G. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 13p. Dep. CFSTI.

An irradiation neutron spectrum plays an important role in the production of irradiation damage. This influence can be demonstrated by comparing damage calculated for the total neutron spectrum of an environment with damage calculated for only the fast neutrons of the spectrum, and damage calculated for a fission spectrum (often assumed equivalent to an irradiation spectrum). (auth)

46088 (BNWL-1144) REACTOR FUELS AND MATERIALS DEVELOPMENT PROGRAMS FOR FUELS AND MATERIALS BRANCH OF USAEC DIVISION OF REACTOR DEVELOPMENT AND TECHNOLOGY. Quarterly Progress Report, April-June 1969. Bement, A. L.; Dau, G. J.; Evans, E. A.; Nightingale, R. E. (eds.). (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 159p. Dep. CFSTI.

Progress is reported in six main sections. A separate abstract was prepared for each section. (J.R.D.)

For abstracts of individual sections see: 46089–46091, 46121, 46144, and 46145.

46089 (BNWL-1144, pp 9.1-9) BASIC SWELLING STUDIES. Hann, C. R. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Swelling was low in specimens of uranium, U–5 wt % Pu, and U–14 wt % Pu–12 wt % Zr irradiated at 1000 psi between 375°C and 625°C. Swelling in U_3Si specimens was greater at lower temperatures. When fissionable metals are irradiated, the ordered metallic structure is perturbed in a number of ways. These effects and their interactions are being studied with regard to the influence of irradiation variables such as the specimen temperature, burnup, burnup rate, and external pressure, and with regard to the influence of metallurgical variables such as composition, structure, and geometry. The data thus far obtained have established that swelling at low burnup in alpha uranium is due to mechanical processes associated with the irradiation "growth" phenomena and with fission-event induced defects rather than with the agglomeration and growth of fission gas pores. This is manifested as a maximum in the swelling-temperature curve in the 400 to 600°C range. A few tenths of a percent alloying addition or an applied external pressure have been found to be effective in overcoming the "mechanical" type of swelling. Swelling continues to decrease above 600 up to approximately 700°C. Above 700°C, fission gas swelling begins to occur. Efforts are continuing to better define the basic mechanisms involved and the interrelationship between burnup, temperature, pressure, and metallurgical state. Fundamental information developed by this program will provide a basis for engineering exploitation of the many beneficial attributes of metal fuels for use in reactor applications. (auth)

46090 (BNWL-1144, pp 11.1-24) FAST REACTOR DOSIMETRY AND DAMAGE ANALYSIS. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Reaction rate ratios can be used to identify changes in neutron spectra since monitors respond differently to neutrons of different energies. Data from the recent EBR-II dosimetry test show a possible change in the spectrum between the low- and high-power tests. Other data from the high-power tests show the spectrum was constant axially in Row 2 up to 4 in. above midplane. Such information on spectra is useful in the analysis of both monitor and irradiation damage data. A set of group-averaged values of the damage function was selected and used to compare measured and damage-function calculated fluences for new experimental ΔTT data. The results provide further validation of the applicability of the damage function. Recent indications of a significant contribution by thermal neutrons to the embrittlement of some ferritic steels have prompted computer experiments on low-energy

displacement spikes such as produced by (n,γ) recoils. Preliminary results with individual 400 eV spikes indicate some clustering at low temperatures but not at elevated temperatures. The CASCADE-type computer code is being reformulated and programmed to simulate damage generation in fcc lattice structure. It will permit a more realistic simulation and widen the scope of simulation to include effects in previously damaged lattices and effects of knock-on atoms with energies greater than 20 keV. In computer simulation studies using the GRAINS code, a 6° tilt boundary in a lattice simulating fcc γ iron was observed to heal upon introduction of a carbon atom in the vicinity of the boundary. A significant reduction in the energy of the system occurred as the carbon atom reached its equilibrium position. (auth)

46091 (BNWL-1144, pp 12,1-75) IRRADIATION DAMAGE TO REACTOR METALS. Blackburn, L. D. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

A total of 162 tensile, creep, and corrosion specimens were discharged from the ETR at the conclusion of Cycle 100. Core I testing in the ATR was completed. A comparison was made of the stacking fault hardening rates produced by quenching, straining at room-temperature, straining at 700°C, and straining at 700°C followed by a half-hour hold under load at 700°C. The results showed that hardening-rate increased in the order: straining plus hold > straining > quenching and that straining plus hold treatment produced a faster hardening-rate than did straining alone was rationalized in terms of the added effect of vacancy-enhanced diffusion. Discontinuous yielding during neutron irradiation was measured in annealed 304 SS at 370°C stressed to 35,000 psi. This phenomenon, induced by irradiation, resulted in an average creep-rate of 6×10^{-5} hr^{-1}. The values of the activation parameters and the stress-dependence of the creep-rate in Zr-2.5 Nb are consistent with the "dislocation-climb" model for creep with short-circuited diffusion. Neutron irradiation can be thought of as adding a stress component for faster creep. The stress arises from an osmotic force on climbing dislocations resulting from the supersaturation of point defects created by irradiation. Irradiation of high purity Fe to 3×10^{21} n/cm^2 (E > 0.1 MeV) at 450°C produces ~1×10^{14} voids of average diameter ~280 Å. Analysis of small-angle scattering from metals irradiated at elevated temperatures yields void diameters consistent with those measured by electron microscopy. An equation describing the effect of fluence and temperature on swelling in solution-treated 304 SS has been refined. Transmission electron microscopy studies of irradiated SS indicates that the nucleation rate of cavities may increase with accumulated exposure. An analysis of carbide distributions in 316 SS indicates an increase of carbides precipitation in irradiated material. Eight BNWL structural materials experiments were discharged from EBR-II. The flux monitors from these discharged experiments are in the process of being counted. Four BNWL weldment experiment pins in subassembly x-067 are to have a goal exposure of 1×10^{22} n/cm^2 (E > 0.1 MeV). Elevated temperature burst tests and 1200°C stress-rupture tests for times less than 1400 hr have been completed on tubing lots E, F, G, & H. Metallography and check chemical analyses have been completed on tubing lot G. Biaxial creep curves on tubing lots E & F have been completed. The results of postirradiation creep-rupture tests on 304 and 316 stainless steel are reported for specimens irradiated in the temperature range of 700 to 900°F and to total fluences from 1×10^{21} n/cm^2 to 1×10^{22} n/cm^2 (EBR-II calculated). Rupture-life reductions were observed for all irradiated specimens. Both increased and decreased creep-rates were observed depending on temperature and stress-level of test and irradiation fluence. Biaxial stress-rupture tests at 1200°F have been initiated on AISI type 304 SS irradiated to 0.8×10^{22} n/cm^2 (E > 0.1 MeV) in EBR-II. Specimens were stressed sufficiently to cause rupture in 0.1 to 1000 hr in unirradiated material. The data suggest some increase in rupture strength for short rupture times and loss in rupture strength for long rupture times for irradiated 304 SS. Strain is observed to be sharply reduced from unirradiated values. Characterization of candidate FTR vessel weldment processes is in progress. Tensile test results are reported for as-fabricated specimens from weldments in 1-inch-thick 304 SS plate. The testing matrix includes four welding processes, three specimen types, and four testing temperatures. This matrix constitutes the baseline mechanical property information to be used on conjunction with the weldment irradiation experiment. Four MK-B-7 type pins containing tensile, creep-rupture, and fatigue specimens have been shipped to the EBR-II site for inclusion in subassembly X067-4F2. The LMFBR cladding fabrication section of the LMFBR fuel and cladding information center is in operation. (auth)

46092 (CNM-R-2(Vol.1), pp 298-309) METAL OXIDATION STUDIES IN RESEARCH REACTORS. Simnad, M. T. (General Dynamics Corp., San Diego, Calif. General Atomic Div.); Morel, J.; Uhlig, H. H. (Massachusetts Inst. of Tech., Cambridge).

A brief review is presented of irradiation effects on oxidation of metals, and experimental techniques to measure the kinetics of metal oxidation in the presence of nuclear irradiation in research reactors are described. The manometric method was selected, whereby the decrease in oxygen pressure of a closed system was followed, arranging the iron specimens at one end of a long aluminum tube. The range of temperatures studied covers both the logarithmic (up to about 220°C) and the parabolic range (above 220°C). In the logarithmic range, the effect of radiation on the first stage oxidation rate is small, but there is a significant increase in the second stage oxidation rate. In the parabolic range, there is an increase in oxidation up to 275°C, above which the effects of radiation appear to be cancelled by thermal annealing. (auth)

46093 (RD/B/N-750) MECHANISM OF HIGH-TEMPERATURE IRRADIATION EMBRITTLEMENT OF STAINLESS STEEL. Waddington, J. S. (Central Electricity Generating Board, Berkeley (England). Berkeley Nuclear Labs.). Jan. 1967. 18p. Dep. CFSTI (U. S. Sales Only).

It was found that irradiation increases the growth rate of wedge cracks in 20Cr/25Ni stainless steel. A fractographic study has revealed the presence of small voids ≈0.5μ diameter on irradiated fracture surfaces which were not apparent in the unirradiated samples. A model, appropriate for the discussion of wedge cracks, was used to correlate these observations. (auth)

46094 THE FATIGUE STRENGTH OF NICKEL CORRODED BY NEUTRON IRRADIATION. Maeng, Sun Chae; Choi, Hyung Sup; Kim, In Sup. J. Korean Inst. Metals, 6: 153-5(Dec. 1968). (In Korean).

Ni samples irradiated with a total neutron dosage of 4.6×10^{18} nvt (1.6×10^{18} and 3.0×10^{18} nvt of fast and thermal neutrons, respectively) for 10 months displayed a 10% decrease in fatigue strength. This is attributed to the formation of fatigue cracks at grain boundaries caused by intergranular corrosion. (Metals Abstr.)

46095 DESORPTION OF CARBON MONOXIDE FROM TUNGSTEN BY BOMBARDMENT WITH ELECTRONS. Clausing, Robert Eugene. Charlottesville, Va., Univ. of Virginia, 1968. 157p.

Thesis.

A mass spectrometric technique has been developed to measure the quantity of neutral molecules released by electron impact from metallic surfaces covered with adsorbed gases and was used to investigate the electron bombardment induced desorption of carbon monoxide from tungsten. The method is sensitive enough to detect the desorption of about 10 molecules during an eight-second bombardment pulse. This sensitivity permits frequent sampling of a surface without significantly perturbing the gas-metal surface; therefore, reactions can be followed as they occur. This technique for studying gas-metal interactions is compatible with other methods including low-energy electron diffraction, flash filament measurements, and the desorption of ions and secondary electrons due to electron bombardment.
It was possible to separate the effects of thermal desorption due to the very small amount of target heating that accompanied the electron bombardment from the effects of electron impact per se. The thermal effects were shown to be negligible for the conditions of this study. They were also shown to be pressure dependent so that they would make an important contribution for the desorption of carbon monoxide from the tungsten target at 300°K for 500 electron volt electrons at ambient carbon monoxide pressures greater than 10^{-8} torr. The desorption of neutral carbon monoxide molecules from a tungsten ribbon with predominantly [100] poles normal to the surface was measured for electron energies in the range from 30 to 8,000 electron volts. Between 3×10^{-6} and 6×10^{-5} molecules were desorbed per incident electron, depending upon the electron energy. The desorption appears to be from the alpha form of chemisorbed carbon monoxide, whose measured population was about 10^{13} molecules per square centimeter. The desorption cross section for neutral carbon monoxide from this alpha state is then calculated to be about 4×10^{-18} square centimeters for electrons having energies of 100 electron volts. The threshold of electron energy necessary to cause desorption is approximately 20 electron volts. The relationship of the desorption cross section to the electron energy is discussed, and a tentative explanation involving several processes is offered. (Disser. Abstr.)

46096 CONCENTRATION DEPENDENCE OF FRENKEL PAIR DEFECT ANNEALING IN ELECTRON-IRRADIATED Ta AND Nb. Myhra, Sverre. Salt Lake City, Univ. of Utah, 1969. 113p.

Thesis.

An investigation of the dose dependence of the annealing spectra

of Ta and Nb from 15 to 285°K after bombardment with 2.2 MeV electrons is reported. Three thin wire Ta samples and two thin wire Nb samples were irradiated at 14°K to different defect concentrations. These samples were then simultaneously annealed isochronally from 14.7 to 285°K going up in temperature steps of roughly 5% of the annealing temperature. In Ta recovery peaks were observed at 23, 51, 65, 123, and 170°K. Only the peak at 170°K shows definite dose dependence. The annealing of this substage obeys a second order rate equation. Recovery peaks were observed in Nb at 26.5, 58, 95, and 135°K. Higher order recovery is observed for the peak at 95°K. This peak starts out obeying second order and then gradually goes to still higher orders towards the end of the stage. It is proposed that a two-interstitia model seems to give the best fit to the observed data. Impurity effects appear to be of considerable importance in their suppression of free migration annealing stages. Several stages are also interpreted as interstitial impurity release processes. There is some evidence that the free migration of the ⟨111⟩ split interstitial can be assigned to substages below 20°K in both Ta and Nb, while the ⟨110⟩ split interstitial is thought to be migrating at the more elevated temperatures of 95°K in Nb and 170°K in Ta. (Disser. Abstr.)

46097 ORDERING PROCESSES IN MARTENSITE IRRADIATED WITH NEUTRONS. Kritskaya, V. K.; Il'ina, V. A. (Inst. of Metal Behavior and Metal Physics, Moscow). Dokl. Akad. Nauk SSSR, 185: 1273-5(Apr. 21, 1969). (In Russian).

A simple carbon steel quenched to martensite was irradiated with 15 MeV neutrons from a Be(p,n) reaction on a cyclotron. The neutron dose was about 10^{15} cm^{-2}. The iron samples were x-rayed before neutron irradiation at a sample-to-film distance of 160 mm. The neutron-irradiated samples were x-rayed under identical conditions. The unirradiated sample showed the tetragonal lattice of martensite with a high content of carbon in solid solution. The neutron-irradiated sample showed a decrease in the tetragonal structure of the martensite lattice. The tetragonal lattice (as evidenced by an increase in the c/a axial ratio) returned with the lapse of 6 to 11 months at room temperature as a result of diffusion and redistribution of the carbon atoms. This redistribution did not require diffusion to considerable distances, but took place in the volume of the elementary cell. It can take place at a noticeable velocity at relatively low temperature. (TTT)

46098 EFFECT OF FAST REACTOR IRRADIATION ON THE TENSILE PROPERTIES OF 304 STAINLESS STEEL. Holmes, J. J.; Robbins, R. E.; Brimhall, J. L. (Battelle-Northwest, Richland, Wash.). Contract AT(45-1)-1830. J. Nucl. Mater., 32: 330-9(Sept.-Oct. 1969).

The tensile properties of 304 stainless steel were investigated after irradiation in the EBR-II to 1.1×10^{22} n/cm^2 ($E > 0.1$ MeV) at 540 ± 50°C. Radiation hardening by dislocation loops and voids caused increases in yield strength to test temperatures as high as 820°C. A corresponding ductility loss was also observed. Below one-half the absolute melting temperature, 0.5 T_m, the ductility loss was found to be caused by plastic instability induced by the increased flow stress and reduced work hardening rates. Above 0.5 T_m, helium embrittlement was thought to control ductility. Dislocation loops and voids do not appreciably alter the high temperature ductility. (auth)

46099 SOME ASPECTS OF THE EFFECTS OF FISSION FRAGMENT IRRADIATION UPON THE OXIDATION OF AUSTENITIC STAINLESS STEELS BY OXYGEN AT 650° AND 800°C. Bennett, M. J.; Chaffey, G. H.; Antill, J. E. (United Kingdom Atomic Energy Research Establishment, Harwell, Eng.). J. Nucl. Mater., 32: 299-309(Sept.-Oct. 1969).

The oxidation of an 18/8/Ti stainless steel by oxygen at 650°C for varying periods up to 3760 hr was enhanced by a fission fragment flux between 6.2×10^8 and 1.7×10^9 $ff/cm^2/sec$ but was not influenced by the associated incident reactor radiation. The enhancement increased with exposure, such that the magnitude of oxidation on the specimens irradiated with fission fragments was greater than on the controls by a factor of between 1.3 to 3.5 and 1.7 to 4.6 after 1000 and 3700 hr respectively. There was no systematic correlation between the extent of the increased attack and the magnitude of the fission fragment flux. The radiation-induced attack would appear to be primarily localized as mounds and is believed to be caused by displacement damage in the protective oxide film as a direct result of fission recoil bombardment. Fission-fragment irradiation did not influence significantly, however, either the magnitude of oxidation or the percentage of non-adherent oxide formed during the oxidation of a 20/25/Nb stainless steel at 800°C. The exposure period varied up to 4252 hr and the fission fragment flux was between 1.13 and 1.53×10^9 $ff/cm^2/sec$. The absence of any irradiation effect at this temperature contrasts with the radiation-enhanced oxidation of this steel observed previously at 650°C. (auth)

46100 REPLY TO THE COMMENTS OF NOVAK AND TRUCHLY ON THE GROWTH OF GAS BUBBLES IN A STRESSED MEDIUM AND THE APPLICATION TO STRESS ENHANCED SWELLING IN ALPHA URANIUM. Harrison, J. W. (United Kingdom Atomic Energy Authority, Harwell, Eng.). J. Nucl. Mater., 32: 363-4(Sept.-Oct. 1969).

Comment in support of the conclusions of the original paper (NSA 21: 45974) concerning gas bubble growth mechanisms in stressed mediums as applied to swelling of alpha uranium is presented. It is noted that the value $10^{12}/cm^3$ for U bubble density agrees with recent measurements. It is also noted that there is evidence in the literature that bubble growth takes place only on grain boundaries oriented to give positive tractions and does not occur on neighboring boundaries where the stress is negative. Distortion free swelling occurs only at temperatures above 350°C. The opinion is offered that pure U swells more readily U containing impurities because of recrystallization. (J.R.D.)

46101 STUDY PROGRAM CONCERNING STEEL FOR REACTOR PRESSURE VESSEL OF NUCLEAR POWER AT DODEWAARD. Schumacher, K.; Wassenaar, K. (Gemeenschappelijke Kernenergiecentrale, Arnhem, Netherlands). Lastechniek, 34: 149-55(June 1968). (In German).

The steel surveillance program applied to the 54 MW(e) GKN Nuclear Power Plant at Dodewaard is described. The program consists of irradiation of bending test samples of stainless steel cladding, irradiation of stress wave attenuation samples under stress and without stress, and irradiation of small sized stainless steel 304 and Zy-2 and -4 plates for corrosion tests. Samples are positioned in 4 different regions where they are exposed to the following integrated neutron fluxes negligible 5.2×10^{18}, $\sim 10^{20}$, and $\sim 1.2 \times 10^{22}$. The stressed samples are subjected to a stress equal to the main stress in the reactor pressure vessel wall (~ 13 kgf/m^2m) at the operation pressure of 70 atm. The stress is transferred to the samples by the reactor pressure itself via a bellows construction. By this, the effect of cycling is also included. (auth)

Ceramics and Cermets

Refer also to abstracts 45984 and 45987–45991.

46102 (LA-4237) CMF-13 RESEARCH ON CARBON AND GRAPHITE. Report No. 10. Summary of Progress, May 1–July 31, 1969. Smith, Morton C. (Los Alamos Scientific Lab., N. Mex.). Sept. 3, 1969. Contract W-7405-eng-36. 37p. Dep. CFSTI.

Activities in research programs conducted by LASL CMF-13 group are summarized. These programs are aimed at increasing understanding and improving manufactured carbons and graphites. Information is included on properties and structure of Santa Maria coke, development of highly oriented polycrystalline graphite, preparation of graphite filler materials, development of graphite binders, evaluation of high temperature properties of graphite, thermal shock effects, properties of boron-doped graphite, carbon allotropy, graphite fuel element cracking, graphite density, and thermal expansion of proprietary graphites. (J.R.D.)

Corrosion and Erosion

Refer also to abstract 46009.

46103 CORROSION RESISTANCE OF THE TRANSITION METAL SILICIDES. Jangg, G.; Kieffer, R.; Prem, E.; Heidler, E. Werkst. Korros., 20: 98-102(Feb. 1969). (In German).

Corrosion tests were carried out in various media on powdered silicides fused in a plasma arc to form fairly uniform globules. The disilicides of Ti, V, Nb, Ta, Cr, Mo, and W, as well as Mo_5Si_3, Mo_3Si, and W_5Si_2 are generally highly resistant to acids, but resist NaOH poorly. Mo and W silicides, however, have little resistance to most acids; the remaining silicides are highly resistant to HNO_3, HCl, and H_2SO_4, but not to HF. The acid resistance is due to the formation of an SiO_2-rich surface layer. (Metals Abstr.)

46104 DIFFUSION-CONTROLLED REACTIONS OF SILICIDES OF HIGH-MELTING METALS. Fitzer, E. (Univ., Karlsruhe, Ger.). Planseeber. Pulvermet., 17: 36-53(Apr. 1969). (In German).

Studies were made on the oxidation processes on high-melting silicides with infinite silicide semi-infinite body, oxidation processes on high-melting silicides with finite semi-infinite bodies, silicon evaporation from silicides, and the preparation of silicide layers on high-melting metals by halogenide reactions. $MoSi_2$ sintered samples were prepared for experimental studies. The results showed that the processes over a long observation time could be described by laminar growth or diffusion coefficients and these could be applied to the previous calculation of complex

processes. The presence of a solid phase free from macropores was assumed, for which the use of mean values for the one-dimensional diffusion passage was permissible. The boundary conditions for the diffusion, which concerned the concentration within the solid phase, must remain the same over the observation time. This appeared promising in the high-melting silicide phase, even in mixtures of several metal components. The problem of the homogeneity of the solid phase was complicated in oxide multicomponent systems. If areas are considered in which the rates of evaporation or surface reactions have the same order of magnitude as that of diffusion processes, then available measurement data on the gross kinetics can be explained only qualitatively and assumptions drawn from the kinetic data of the individual steps have the value of only a rough estimation. Basic knowledge of the diffusion kinetics are necessary before new developments are made in the very slow oxide reactions in oxidation protection systems. (tr-auth)

Preparation and Fabrication

Refer also to abstracts 46015–46019, 46023, 46104, 46134, and 47342.

46105 (BAW-3714-14) GEL-ADDITION PROCESS CHEMICAL STUDIES. Quarterly Progress Report No. 12, May–July 1969. Carlson, R. V. (comp.) (Babcock and Wilcox Co., Lynchburg, Va. Research and Development Div.). Sept. 1969. Contract AT(30-1)-3714. 14p. Dep. CFSTI.

The development of a sol-gel process and related processes for preparing (U, Pu)O_2 fast reactor fuels has continued. The preparation of UO_2–20% PuO_2 fuel in the form of sol-gel microspheres and coprecipitated power for thermal reactor testing was completed. Preparation of fuel containing 20% PuO_2 in UO_2 enriched to 93% ^{235}U for irradiation in the fast reactor conditions obtainable in EBR-II was initiated. The seventh capsule in a series designed to show the differences in restructuring kinetics of pellets and vibratory compacted spheres and shards was irradiated in the BAWTR. The linear heat rate was about 18.5 kW/ft, and the exposure time was 1 EFPD. This capsule, as well as the six that were irradiated previously, is cooling pending hot cell examination. (auth)

46106 (CEND-3107-351) BURNABLE POISON ADDITIONS TO UO_2. Summary Report, May 1, 1967–June 30, 1968. Andrews, M. G.; Taylor, W. C.; Zuromsky, G. (Combustion Engineering, Inc., Windsor, Conn. Nuclear Power Dept.). Mar. 1969. Contract AT(30-1)-3107. 62p. (EURAEC-2123). Dep. CFSTI.

Work performed under United States–Euratom Joint Research and Development Program.

One of the means by which burnable poisons can be used for reactivity control in power reactors is to add controlled amounts of a poison directly to the fuel material as a homogeneous dispersion. The addition of boron to UO_2 has been limited by the lack of a suitable fabrication technique which would produce the desired properties in the fuel. Activities in a program to develop the sintering techniques capable of incorporating approximately 400 ppM of natural boron in UO_2 pellets and to attain sintered densities in excess of 90 percent of theoretical are reported. B_4C was added to UO_2 and sintered in argon, hydrogen (argon-10 wt % H_2), vacuum, and CO_2-CO environments at temperatures up to 1600°C. Pellets prepared from essentially stoichiometric UO_2, containing 12 ppM boron in the form of B_4C, retained 60 to 75 percent of the boron when sintered in argon or in vacuum. Similarly prepared pellets of UO_2 containing 900 ppM boron retained only 10 to 40 percent of the boron under the same sintering conditions. The pellet densities associated with these high boron losses were less than the target 90 percent of theoretical. The loss of boron during sintering is attributed to the reaction of B_4C with moisture and excess oxygen in the UO_2 to form boron oxides which volatilize at temperatures between 1300 and 1600°C. The use of a reducing environment to remove oxygen from hyperstoichiometric UO_2-B_4C pellets during sintering was unsuccessful in improving the retention of boron. Boron which was retained was in the form of UB_4 which formed by reaction of UO_2 and B_4C at temperatures above 1400°C. (auth)

46107 (CONF-690815-3) THE PRODUCTION OF NUCLEAR GRADE URANIUM DIOXIDE POWDERS FROM AUSTRALIAN ORES. Metallurgy Paper No. 3. Alfredson, P. G. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). Mar. 19, 1969. 19p. Dep. CFSTI (U. S. Sales Only).

From Conference of the Australian Institute of Mining and Metallurgy, Sydney, Australia.

Most types of nuclear power reactors use uranium dioxide fuel. Power reactors using natural uranium dioxide fuel are of special interest to countries such as Australia that have their own uranium supplies. A wide range of uranium dioxide powders can be fabricated and the ideal one flows readily, presses without the need for binders or lubricants, sinters to the required density, and gives low reject rates at all fabrication stages. Sinterable uranium dioxide is usually produced via the ammonium diuranate route. The A.A.E.C. is aiming to demonstrate production of nuclear grade uranium dioxide from Australian concentrates, improving technology where possible. Details are given of the dissolution, solvent extraction, precipitation, filtration, drying, and calcination-reduction steps. Solvent extraction from sulphate media is also under study with a view to developing a process to produce a nuclear grade product at the mine treatment plant site. (auth) (Australia)

46108 (ORNL-4398) SOL-GEL PREPARATION OF SPHERES; DESIGN AND OPERATION OF FLUIDIZED BED COLUMNS. Haas, Paul A. (Oak Ridge National Lab., Tenn.). Sept. 1969. Contract W-7405-eng-26. 66p. Dep. CFSTI.

Sol-gel processes for preparing microspheres of uranium and thorium oxides for use as fuel for nuclear reactors were developed at Oak Ridge National Laboratory. These processes involve the continuous operation of fluidized-bed columns in which sol drops are converted to gel spheres by extraction of water. Available information for designing and operating fluidized-bed columns is summarized; emphasis is on variables other than the sol characteristics. Among the problems considered are: premature discharge of incompletely gelled particles from the sphere-forming column, formation of nonspherical gel particles, and capacity limitations of the equipment. The correct configuration for the column and the use of a tangential fluid inlet to create a swirling motion of the liquid are important factors in ensuring good fluidization. Successful continuous operation requires control of the composition of the fluidizing mixture by the addition of surfactants and the operation of a still to remove water. Capacities under normal conditions, in terms of grams of oxide spheres per hour, are estimated to be from 100 g/hr for dilute sols, using a 1-in.-ID (minimum) column, to 9000 g/hr for concentrated sols, using a 3-in.-ID (minimum) column. The dispersion of sol into uniform drops is also important to continuous and efficient operation; four useful dispersion techniques are described. (auth)

46109 (Y-1684) FIBER-REINFORCED GRAPHITE COMPOSITE FABRICATION AND EVALUATION. Lambdin, F.; Cook, J. L.; Marrow, G. B. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 4, 1969. Contract W-7405-eng-26. 57p. Dep. CFSTI.

Composites consisting of carbon fibers (2 microns in diameter by 10 mils long), and either of a thermoplastic or thermosetting resin, were spray formed onto graphite mandrels, carbonized to 1,000°C, and densified by repeated impregnation-carbonization cycles. Sections up to one inch in thickness and ranging in density from 0.2 to 1.7 g/cc have been fabricated using spraying as the basic fabrication method. Isostatic and match-die compaction were used to increase the fiber population. Preliminary physical and mechanical properties of these composite materials were evaluated, and several were investigated to determine their performance under ablation conditions. (auth)

46110 (Y-DA-2654) CARBON COMPOSITE MATERIALS (Second Issue). McLaughlin, L. M. (Union Carbide Corp., Oak Ridge, Tenn. Y-12 Plant). Sept. 18, 1969. Contract W-7405-eng-26. 314p. Dep. CFSTI.

Reviews are presented on fabrication methods and properties of carbon-base thermal insulation, properties of pyrolytic graphite, fibrous graphite, and carbon foam, preparation and properties of high-carbon compounds, properties of porous graphite, and morphology of rigid-foam carbon. (J.R.D.)

46111 CHANGES IN THE COBALT PHASE DUE TO ATTRITION DURING THE WET MILLING OF CARBIDE–COBALT MIXTURES. Mariacher, Hans; Horn, Elisabeth; Brendt, Manfred; Schell, Kurt. Dew Tech. Ber., 8: 249-56(Nov. 1968). (In German).

Attrition during the wet grinding of 94% WC + 6% Co and 94% Cr_3C_2 + 6% Co was investigated in relation to changes occurring in the Co phase. Comparative tests showed that the specific surface area increase was greater with Cr_3C_2 than with the WC material, as was the increase in sub-sieve size of the particles. Electron-microscope studies showed that Cr_3C_2 has less tendency to coalesce than Co which results in a relative increase in the fraction of fine Co particles, formed during the milling. The formation of Co films upon carbide particles was also studied using electron microscopy; the breaking of such films during the grinding of Cr_3C_2 composites explains the formation of large quantities of very fine Co particles. The O uptake during milling does not increase as the specific surface area increases. (Metals Abstr.)

46112 PROCESSES FOR THE PRODUCTION OF NUCLEAR GRADE URANIUM DIOXIDE. Cairns, R. C. P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Mech. Chem. Eng. Trans., MC4: 227-33(Nov. 1968).

Processes for production of U compounds associated with the nuclear industry are reviewed. Production processes for nuclear grade UO_2 are discussed along with those for high-density fuel. Flowsheets for U compound production are included along with information on cost and process development. (J.R.D.)

46113 PRELIMINARY NOTE ON THE PROPERTIES AND STRUCTURE OF THORIA-BASE DISPERSIONS. Haydt, Heliton Motta; Capocchi, Jose Deodoro Trani; Cintra, Sebastiao Hermano Leite; Gentile, Erberto Francisco. Metalurgia (Sao Paulo), 25: 111-17(Feb. 1969). (In Portuguese).

Experimental production of reactor fuel elements incorporating cermets consisting of a dispersion of ThO_2 in Al powder is reported. Compacts of ThO_2–Al, ThO_2–UO_2–Al, and ThO_2–U_3O_8–Al were prepared using thoria obtained by roasting thorium oxalate and thorium sulfate. In the range of pressures studied, a linear relation was found between cermet density and compaction force. Compacts made with ThO_2 obtained from the oxalate, especially at 70% Al, had a higher percentage of the theoretical density than with ThO_2 obtained from the sulfate. Cermet brittleness during hot rolling and imperfect bonding of core and sheathing were more pronounced when working with material orginating with the sulfate. Rolling conditions were better when the cermets contained U_3O_8. The ThO_2–U_3O_8–Al mixtures in which the ThO_2 was derived from the oxalate were less homogeneous than others. (Metals Abstr.)

46114 STUDY ON TUNGSTEN CARBIDE. Kim, Jae Won; Chang, Hyung Goo. J. Korean Inst. Metals, 6: 73-82(Sept. 1968). (In Koran).

The formation of WC in CO atmospheres was studied as a function of CO partial pressure and temperature. The equilibrium constant (K) and the free-energy change (ΔG), for the reaction $W + 2\,CO = WC + CO_2$, were $\log K = 10.950\,T - 10.11$ and $\Delta G = -50.129 + 46.3T$, respectively. (Metals Abstr.)

46115 THE STUDY OF ZIRCONIA PRODUCTION BY CAUSTIC FRITTING OF ZIRCON. Lee, Kang Ill; Kim, Yung Bin; Oh, Jae Kyun; Kang, Woong Ki. J. Korean Inst. Metals, 6: 174-9 (Dec. 1968). (In Korean).

The optimum conditions for the production of technical grade zirconia by the caustic fritting of zircon are described. (Metals Abstr.)

46116 FUNDAMENTAL LAWS OF THE HIGH-FREQUENCY ELECTRO-EROSION MACHINING OF A HARD ALLOY. Zlobin, G. P.; Gamov, O. P. Elektron. Obrab. Mater., No. 1, 85-8(Jan.-Feb. 1969). (In Russian).

The high-frequency electro-erosion machining of a WC–Co hard alloy (20 to 70 kc/sec, pulse length 2 to 4 μsec) was studied experimentally and some general laws governing the efficiency of this process in relation to the technological conditions were derived. For example, the machining rate depended on the length and energy of the applied pulses, the nature of the electrodes employed, the type of surrounding medium (kerosene, water, etc.) and so on. The precision of the machining process depended on the accuracy of manufacture of the electrodes and the efficiency of the mechanism controlling the movement of them. (Metals Abstr.)

46117 CONTROL OF HARD METAL ALLOYS BY ELECTRON AND OPTICAL MICROSCOPE EXAMINATION. Mader, W.; Mueller, K. F. Radex Rundsch., No. 1, 416-20(Feb. 1969). (In German).

The usefulness of the sintered 10% Co–90% WC alloy lies in its high density, hardness, magnetic properties, and tensile strength. Instead of measuring these properties directly, testing and control may be exercised by examination under the electron or optical microscope. A program of investigation was carried out relating density, hardness, and strength to grain size, and magnetic coercivity to Co content. (Metals Abstr.)

46118 CONVERSION OF URANIUM OXIDE MICROSPHERES TO URANIUM CARBIDE MICROSPHERES. Buono, M.; Ceccotti, G.; Olivi, A. (CAMEN, Pisa, Italy). Energ. Nucl. (Milan), 16: 511-19(Aug. 1969). (In Italian).

A laboratory method was established to convert UO_2 microspheres into UC_2 microspheres through diffusion of solid state carbonium. 1500 to 1750° heat treatments were carried out with microspheres of 80 + 320 μ radius. The C–UO_2 contact which gave positive results has been obtained in a rotating graphite reactor, containing graphite powder, at a 10^{-4} Hg pressure and at ambient pressure in argon flow. Results have been checked by ceramographic examination and chemical analysis. (auth)

Properties Evaluations

Refer also to abstracts 45485, 46045, 46050, 46052, 46053, 46068, 46110, and 46559.

46119 (ANL–7520(Pt.1), pp 441-7) EVALUATION OF CARBON ACTIVITY SOURCES IN SODIUM. McKee, John M.; Caplinger, Wayne H. (United Nuclear Corp., Elmsford, N. Y.).

The carbon activity produced in sodium by various additives was explored in a series of 25 capsule tests at 1400°F. The carbon flux through the iron capsule wall into a stream of decarburizing gas was taken as a measure of the carbon activity. Very high carbon activity was produced in sodium by unstable carbides and by graphite plus large amounts of oxygen. Stable carbides, sodium cyanide, and graphite without oxygen produced low but significant activities. (auth)

46120 (ANL–7520(Pt.1), pp 448-54) CARBON IMPURITIES IN SODIUM SYSTEM COLD TRAPS. Dutina, D.; Simpson, J. L. (General Electric Co., Pleasanton, Calif. [Nuclear Technology Dept.]); Young, R. S. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation).

Tests revealed that at least 5 forms of carbon were found in a cold trap fabricated of ferritic steel. Both the cyanide and carbonate anions were observed, and it was inferred that carbides, elemental carbon, and a methane-yielding species were present. In a continuation of the study, a second trap fabricated from an austenitic steel loop was put into use and a comparison of the data obtained for the two systems was made. The carbon species present in the sodium loop were carbonate, cyanide, carbides, methane, and elemental carbon. The relationship to the mechanism of carbon transport in the stainless steel and ferritic loops is discussed. The results showed that the total amount of carbon deposited in the trap from the ferritic loop was three times that found in the deposits in the stainless steel system. The difference is due mainly to the increased amount of complex carbon form in the ferritic-loop deposits. (J.C.W.)

46121 (BNWL–1144, pp 5.1-40) NUCLEAR CERAMICS. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Installation of the high-temperature vacuum resistance furnace in a plutonium glove box located in the Shielded Materials Facility was completed. This arrangement will be used for measurements of liquid density, viscosity, surface tension, and compressibility on both unirradiated and irradiated mixed-oxide fuels to 300°C. Techniques are described for obtaining the surface tension of liquid oxides by analyzing the shapes of pendant drops and capillary menisci which have been radiographed in closed refractory-metal capsules. Values of the surface tension of liquid Al_2O_3 found by using these techniques are in good agreement with values reported in the literature. The electric conductivity of CeO_{2-x} was measured to 2000°C in argon. The increase in conductivity with a decrease in oxygen content and the anomalous decrease above 1900°C was confirmed. A study was carried out to determine a method of preparing polycrystalline UO_2–25 wt % PuO_2 creep specimens. Several different mechanically-mixed and coprecipitated powders were compacted and sintered under various conditions, and the resultant microstructures were examined. Results indicate that in order to obtain uniform pellets for creep studies, coprecipitated powders must be used. Photomicrographs were obtained for coprecipitated mixed oxide thermal diffusivity specimens which contained 0, 5, 12, 20, 25, 30, and 45 wt % PuO_2. The information obtained from the photomicrographs was correlated with thermal diffusivity data previously reported. An experimental system was constructed to examine the feasibility of measuring oxygen/metal ratios in oxide fuel samples weighing about 1 mg. It was found that outgassing of the graphite crucible used in the fuel reduction contributes an appreciable fraction of the CO_2 measured to determine the oxygen content of the fuel sample. The study of mixed-oxide fuels, using scanning electron microscopy, continued with detailed examination of calcination of plutonium oxalate and nitrate to form PuO_2, and of sintering of PuO_2 and UO_2–PuO_2. Correlations between calcination temperature, physical treatment of powders, measured particle sizes, sintered densities, microstructure, and microcomposition are being developed. (auth)

46122 (IS–T–314) EFFECT OF DISPERSIONS ON THE DUCTILITY OF CHROMIUM. Vormelker, Philip Robert (Ames Lab., Iowa). May 1969. Contract W-7405-eng-82. 51p. Dep. CFSTI. Thesis.

The effects of thoria dispersions on the brittle-ductile transition temperature and the yield stress of chromium have been investigated by bend tests. Chromium alloys containing up to 7.39 volume % thoria were prepared by powder metallurgy techniques. One alloy series, having an average thoria particle diameter of 1.8μ, was shown to have a decreasing transition temperature with increasing

thoria content. A second alloy series to which thoria of 1.6μ in diameter was added, showed an interesting transition temperature. The bend yield stress exhibited this same divergent behavior between the two alloy series while the hardness increased over the same thoria concentration range. The divergent behavior between the two alloy series in both transition temperature and yield stress has been tentatively attributed to impurity effects. An attempt was made to confirm the Hahn and Rosenfield model which predicts ductility enhancement for alloys strengthened by a fine, hard particle dispersion. The results of studying chromium-thoria alloys were inconclusive due to the contrast in brittle-ductile transition temperature of the two alloy series and the nonuniformity of the dispersion. (auth)

46123 (STI/PUB-21/33) URANIUM CARBIDES, NITRIDES, AND SILICIDES. VOL. III (1966–1967). Bibliographical Series No. 33. (International Atomic Energy Agency, Vienna (Austria)). 1968. 110p. IAEA $3.50. Dep.

A bibliography of 520 references to the literature published during the period 1966–1967 is presented. Most references are provided with abstracts in English. The main bibliographical sources were: Nuclear Science Abstracts, Referativnyi Zhurnal–Khimiya, Chemical Abstracts, and Nuclear Science Abstracts of Japan. For ease of reference an author index and a subject index are included. (auth)

46124 MEASUREMENT OF THERMAL DIFFUSIVITY OF SINTERED CERAMICS. Kim, Pil Hyon; Namba, Susumu; Uenaka, Masao; Suge, Yoshio. Rikagaku Kenkyusho Hokoku, 44: 191-6(1968). (In Japanese).

The thermal diffusivity (conductivity) of sintered Al_2O_3, BeO, and ThO_2 was measured over the temperature range 20 to 500°C by a modified Angstrom method. One end of a sample rod was heated by a source, the power of which varies sinusoidally with time and the heat wave is transmitted through the sample. At two reference points within the sample both velocity and decrements of the heat wave are measured to determine the heat conductivity. This property of Al_2O_3 is higher than the reported value below 300°C and that of ThO_2 agrees to within 10%. (Metals Abstr.)

46125 BOND STRENGTH CHARACTERISTICS OF ELECTRODEPOSITED NICKEL ON BORON AND SILICON CARBIDE FILAMENTS (REINFORCED COMPOSITES). Greco, V. P.; Wallace, W. A.; Cesaro, J. N. L. Plating, 56: 262-70(Mar. 1969).

The mechanical properties of filament-reinforced composites consisting of B and silicon carbide filaments in an electrodeposited Ni matrix from the sulfamate bath have been investigated. Specific attention is given to filament strength and bond strength characteristics of the filament-matrix interface and the effects of current density, filament surface etching, and heat treatment up to 650°C. Bond strength values of single filament composites are measured by pull-out technique using the Instron testing machine. Low strength levels of multifilament composites are related to failure modes studied with single filament composites. (Metals Abstr.)

46126 INTERACTION OF NITRIDES WITH OXYGEN AND OXIDES. Gurevich, Yu. G. Izv. Vyssh. Ucheb. Zaved., Chern. Met., No. 12, 18-22(1968). (In Russian).

The behavior of Ti nitrides under oxiding conditions both as synthetic powdered Ti nitride, and in microsections of steel Kh18N10T with increased N content, was examined. The oxidation of these nitrides with O and oxides has a marked influence on the processes of formation, distribution, and removal of these inclusions. Calculation of the isobar-isothermal oxidation potentials for Ti, Al, V, and B gives results which are in agreement with experimental values. (Metals Abstr.)

46127 OUTGASSING OF Al_2O_3 AND BeO IN VACUUM AT 540 AND 870°C. McRae, Russell C. (Varian Associates, San Carlos, Calif.). Amer. Ceram. Soc. Bull., 48: 559-62(May 7, 1969).

In Rankine cycle space power generators using potassium as the working fluid, and containing ceramic and metal components, the corrosive properties of the potassium are increased by traces of oxygen. As part of the development of ceramic-metal seals for such systems, the possibility of contamination of potassium due to outgassing of the ceramic was considered. Three materials were selected for study as representing different fabricating and sintering procedures. Alumina and beryllia ceramics are normally fabricated by sintering in an oxidizing atmosphere for ½ to 3 hr between 1500 and 1700°C. Dissolved, chemisorbed, and occluded oxygen-containing gases (H_2O, CO, CO_2) formed during this sintering can be released during subsequent treatment or use of the ceramic at elevated temperatures. A mass spectrometer was used to determine the amount of gaseous oxygen compounds remaining in 100% Al_2O_3 (sapphire), 99.7% Al_2O_3, and 99.8% BeO bodies after selected cleaning and firing schedules. Partial pressure plots of evolved gases vs time for 20-min outgassing runs at 540 and 870°C are presented with total evolved gas quantities. (BBB)

46128 HEATING CURVES AND MELTING POINT MEASUREMENTS WITH A SOLAR FURNACE. Noguchi, Tetsuo; Mizuno, Masao; Kozuka, Takeshi; Yamamoto, Tetsuo. Nagoya Kogyo Gijutsu Shikensho Hokoku, 17: No. 5, 120-6(May 1968). (In Japanese).

The heating curves, melting points, and freezing points on cooling of metals with high melting points were measured by using a heliostat-type solar furnace and a brightness pyrometer. The time required to fuse the specimens as a function of irradiance can also be measured from the curves. The melting points of ZrO_2 and Y_2O_3 were 2995 ± 20 and 2686 ± 20°K, respectively. (Metals Abstr.)

46129 THE EFFECT OF IMPURITIES IN WO_3 ON PROPERTIES OF CEMENTED CARBIDES. Vicha, V. Pokroky Praskove Met. VUPM, No. 3, 15-33(1968). (In Czech).

The effects of impurities present in various amounts in WO_3 and their influence on reduction and carburization of WO_3 and on properties of cemented carbides were studied. Reduction, carburization of WO_3, and the properties of cemented carbides were unfavorably affected by Na_2O, Zn, MgO, SiO_2, Al_2O_3, Sn, and CaO. The properties of cemented carbides improved after addition of Mo, P, Cr, and Ni; the effects of these latter additions on reduction and carburization were negligible. The cutting efficiency decreased in the presence of SiO_2, Na_2O, and Al_2O_3 in several cemented carbides. The highest cutting efficiency was observed in the presence of P 0.25, Cr 0.3, and CaO 0.15%. (Metals Abstr.)

46130 METHOD FOR DETERMINATION OF THE THERMAL CONDUCTIVITY OF NUCLEAR FUEL SAMPLES DURING IRRADIATION IN A REACTOR. Glanz, G. (Institut fuer Atomphysik, Bucharest). Rev. Roum. Phys., 13: 829-35(1968). (In German).

The Angstrom method was applied to the measurement of the thermal diffusion of small samples during their irradiation in the reactor. In the capsule described, samples can be irradiated in the presence of a gas at controllable temperatures with a heat release up to 50 W. The method was experimentally verified by measurements on fused silica, steatite, and SiO_2–UO_2 systems. The error obtained is characteristic of that in dynamic methods. The electric conductivity and the thermoelectric force can be determined in the capsule during the irradiation. (tr-auth)

46131 REFRACTORY MATERIALS FOR SPACE USE. Geier, M. (Institut Univ. de Technologie et a l'Ecole Technique Superieure, Brest, France). Metaux (Corros.-Ind.), 44: 92-128(Mar. 1969). (In French).

The requirements imposed on materials by the special conditions of operation of space vehicles, by high temperature utilization, by re-entry into the atmosphere, and by the space environment are summarized. The metals and alloys used for space and their characteristics which make them desirable are reviewed. Be, graphite, commercial graphite, ceramic products, and composite materials are considered in detail. (J.S.R.)

46132 THERMAL EXPANSION OF CERMETS CONTAINING URANIUM DIOXIDE. Tummala, R. R.; Friedberg, A. L. (Univ. of Illinois, Urbana). J. Nucl. Mater., 32: 354-6(Sept.-Oct. 1969).

It is pointed out that an equation used to interpret the observed thermal expansion in the form of $\alpha T = \{[\alpha_1 + x_2(\alpha_2 - \alpha_1)]\frac{1}{2}(1 - \sigma)/\frac{1}{2}(1 - \sigma) + x_2(1 - 2\sigma_1) + (1 - x_2)(E_1/E_2)\}$ where α, x, σ, and E are respectively the thermal expansion coefficient, volume fraction, Poisson's ratio, and Young's modulus; and subscripts 1, 2, and T refer respectively to the dispersed phase, the matrix, and the cermet, does not represent the expansion curve for UO_2–stainless steel. An equation in the form of $\alpha = \alpha_2(1 - x_1A) + \alpha_1x_1A$ where A is a constant defined in terms of component properties in the equation $A = \{\frac{1}{2}(1 + \sigma_2)/E_2/[\frac{1}{2}(1 + \sigma_2)/E_2] + (1 - 2\sigma_1)/E_1\}$ is applicable to a variety of systems such as ceramic glass, metal-metal, and organic-metal. (J.R.D.)

46133 MATHEMATICAL MODEL FOR CALCULATING STRESSES IN A FOUR-LAYER CARBON–SILICON–CARBIDE-COATED FUEL PARTICLE. Kaae, J. L. (Gulf General Atomic Inc., San Diego, Calif.). J. Nucl. Mater., 32: 322-9(Sept.-Oct. 1969).

A previous mathematical model for calculating stresses in the coatings on a three-layer carbon–silicon-carbide-coated fuel particle has been extended to the case of a four-layer coating. The four layers considered are: low-density carbon, dense isotropic carbon, silicon carbide, and dense isotropic carbon. The assumptions used in the model and the mathematics of the calculations are

similar to those of the previous model. However, a possibility of separation at the inner carbon–silicon-carbide interface has been considered, and in that case the volume available to the fission gases cannot be considered to be independent of the displacement of the inner coating. In general, it appears that the stresses due to the initial fast-neutron-induced densification of the carbon are more severe in the inner carbon than in the outer carbon. Separation at the inner interface can relieve these stresses, but it raises the possibility of high stresses in the inner carbon at a later time. (auth)

46134 FIBER-REINFORCED CERAMICS. Bowen, D. H. (United Kingdom Atomic Energy Research Establishment, Harwell, Eng.). Fibre Sci. Technol., 1: 85-112(Oct. 1968).

Studies of theoretical and experimental ceramic materials are reviewed, including reactor graphite, thoria, urania, zirconia, and beryllia in the whisker and fiber forms. The theoretical strengths of many nonmetallic solids are among the highest of any materials and ceramics in whisker or fiber form are attractive as reinforcing agents on account of their high specific strength and stiffness. Fabricated ceramic bodies, on the other hand, tend to fracture catastrophically at relatively low stresses, particularly when subjected to thermal or mechanical shock. Some of the characteristic mechanical properties of ceramics and possible ways of improving strength and toughness are discussed and the literature on fiber-reinforced ceramics is reviewed. In addition to improving mechanical properties, the presence of fibers having a higher thermal conductivity than that of the matrix may be effective in reducing thermal gradients in the composite. An application where this concept would be particularly advantageous is in ceramic nuclear fuels where very steep thermal gradients may exist owing to their normally poor thermal conductivity and high thermal rating. Study of the properties of uranium dioxide reinforced with molybdenum showed that the addition of 15 vol % of fibers raised the thermal conductivity by 30%. However, undesirable neutron absorption and corrosion problems were associated with the fibers. Degradation of refractory metal fibers during fabrication is a major obstacle to a full realization of the properties of such composites and limits their use at elevated temperatures. Although it may be possible to satisfy the physical conditions for reinforcement, chemical compatibility of fibers and matrix may impose severe restrictions on the choice of materials, particularly for service at high temperatures. (BBB)

46135 A BIBLIOGRAPHIC SURVEY ON ZIRCONIUM ANODIC OXIDE. PART 2. Dassu, G. (Politecnico, Milan); Alessandrini, G.; Peruzzi, R. Energ. Nucl. (Milan), 16: 500-10(Aug. 1969).

Zirconium belongs to the class of metals (valve metals) which, if anodic, are easily oxidized in aqueous solution. Up to now anodic oxidation has been investigated theoretically, while its possible practical application has been neglected. The anodizations by electrolytes different as for nature and concentration have led to the conclusion that usually an adherent and compact anodic oxide is formed, while its properties and characteristics may vary mainly as a consequence of incorporated anions. The relation between bath composition and oxide growth kinetics are not yet well known. Measurement methods of oxide thickness are particularly investigated: these measurements lead to the knowledge of the growth law and make it possible to check a growth model. Ionic and electronic transport laws at high fields have been partly checked from an experimental point of view. They seem to be valid only for thin oxide layers. The growth mechanism is better described by functional expressions. The thermodynamic parameters worked out by this relation are quite satisfying. The phenomenon being too complex to be described in detail, the proposed model can be accepted. The growth of zirconium anodic oxide layer is due to oxygen ion diffusion through the oxide itself, under the action of the high electric field. The oxide morphology investigation is important in aspects such as compactness, homogeneity, and adherence. (J.R.D.)

46136 DEVELOPMENT OF NITRIDED BORON REINFORCED METAL MATRIX COMPOSITES. Vidoz, A. E.; Camahort, J. L.; Crossmann, F. W. J. Compos. Mater., 3: 254-61(Apr. 1969).

The development of a submicron boron nitride coating has substantially improved the stability of B filaments in metallic matrices. It is now possible to think in terms of continuous casting techniques for the fabrication of low-melting metal matrix composites like Al/B. The boron nitride coating also contributes to the formation of void-free Ni/B composites by electroforming processes and reaction-free Ni/B and Ti/B composites by diffusion bonding methods. Mechanical properties of 60 to 70 vol % nitrided B/6061 Al composites prepared by continuous liquid infiltration are discussed. The effects of heat treatment on these composite strengths are also considered. (Metals Abstr.)

Structure and Phase Studies

Refer also to abstract 46074.

46137 (JUL-597-RW) ON OPTICAL METHOD FOR DETERMINATION OF LOCAL ANISOTROPY IN PYROLYTIC CARBON LAYERS AND GRAPHITE. Gruebmeier, H. B.; Scheidler, G. P. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Reaktorwerkstoffe). May 1969. 24p. (In German). Dep. CFSTI (U. S. Sales Only).

The anisotropic structure of pyrolytic carbon on coated particles to be used in nuclear fuel elements can be determined by an optical method which measures the intensity of reflected polarized light in two perpendicular directions with a microscope photometer. The degree of orientation can be described by an optical anisotropy factor, which is related experimentally to the BACON anisotropy factor. A theoretical relation has been found between the optical anisotropy factor, the orientation parameter of BOKROS, and the BACON anisotropy factor, which fits the experimental values. (auth)

46138 THE SYSTEM ZIRCONIUM–SELENIUM. STRUCTURE OF THE PHASES Zr_3Se_4 AND Zr_2Se_3. Salomons, W.; Wiegers, G. A. Rec. Trav. Chim., 87: 1339-44(Dec. 1968).

Mixtures of Zr (99% pure) and Se (99.99%) having initial compositions between $ZrSe_{0.8}$ and $ZrSe_{2.0}$ were heated to 800, 950, and in some cases 1200°C in evacuated quartz tubes. Most of the samples were quenched to room temperature although some were allowed to cool more slowly. The structure of the samples was investigated using x-ray diffraction techniques. The phases $Zr_{1+x}Se_2$ and Zr_3Se_4 were observed in agreement with earlier work. The phase Zr_3Se_4 had a rhombohedral unit structure, intermediate in type between $CdCl_2$ and NaCl, with lattice parameters a = 3.753 and c = 18.703 Å. A newly observed phase with an approximate composition of Zr_2Se_3 and lattice parameters a = 3.744 and c = 12.51 Å and an hexagonal unit cell was found in samples prepared at 950 and 1200°C. This phase was isotypic with Ti_2Se_3. (Metals Abstr.)

46139 COLUMNAR GRAIN GROWTH IN AXIALLY HEATED URANIA BASED SINTERS. Amato, I. (FIAT, Turin); Colombo, R. L. J. Nucl. Mater., 32: 351-3(Sept.-Oct. 1969).

Columnar grain growth in sintered UO_2 in steep temperature gradients was investigated using cylindrical pellets composed of 80 wt % UO_2 + 20 wt % CaO-stabilized ZrO_2, and pellets composed of 50 wt % UO_2 + 50 wt % Al_2O_3. Results of the experiment indicate that the tendency to columnar grain growth is very general and does not need the operation of a particular mechanism to be effective. Micrographs illustrating grain growth are included. (J.R.D.)

46140 INVESTIGATIONS ON THE COMPATIBILITY OF URANIUM MONONITRIDE WITH MOLYBDENUM, TUNGSTEN, AND THORIUM OXIDE AT HIGH TEMPERATURES. Politis, C.; Thuemmler, F.; Wedemeyer, H. (Kernforschungszentrums, Karlsruhe, Ger.). J. Nucl. Mater., 32: 181-92(Sept.-Oct. 1969). (In German).

After annealing uranium mononitride and UN–Mo mixtures on molybdenum supports above 2000°C under a vacuum of 10^{-2}–10^{-5} torr, a molybdenum content of about 0.23 wt % in UN along with an increase of the UN lattice parameter at room temperature was observed. Though the appearance of substoichiometric uranium mononitride seems, in principle, to be possible, the cooling rate may not be sufficient to freeze in this condition. The decomposition of UN initiated at high temperatures under vacuum results in a γ–U–Mo-phase which can be detected by metallographic and x-ray methods; by microprobe analysis about 21 to 22 wt % of Mo and 78 wt % of U were detected. Moreover, the microanalytical studies showed up appreciable amounts of nitrogen (about 1 wt %). On the molybdenum, sheet supports, UO_2-crystals orientated in [111] direction can be detected subsequent to annealing at 2400°C under N_2 and x-ray diffraction also revealed a UN_{2-x}-phase with a lattice constant a_0 = 5.344 Å. The x-ray studies with annealed UN–tungsten specimens up to 2400°C do not give indications on possible reactions or solubilities. Changes in the lattice parameters were not observed. After annealing of UN–ThO_2-mixtures carried out on tungsten-sheet- and ThO_2 supports no remarkable change in the UN lattice parameter is detected up to 2400°C under 500 torr of nitrogen. After annealing on molybdenum supports a slight change Δa_0 = 0.005 Å is measured following annealings at 1750 and 2000°C under vacuum. However, the UO_2 impurities form a solid solution together with thorium oxide, as can be observed by the variation of the lattice constants. The upper temperature limits of satisfactory compatibility strongly depends on the annealing atmosphere. In the case of UN–Mo under 10^{-5} torr of N_2 it is at 1550°C and rises to about 2300°C under 300 torr of N_2. Slightly higher temperatures are applicable to UN–W. (auth)

46141 MIXED-PHASE FORMATION OF THE MONONITRIDE IN THE SYSTEM U–(Y, La, Pr)–N. Holleck, H.; Smailos, E.; Thuemmler, F. (Kernforschungszentrums, Karlsruhe, Ger.). J. Nucl. Mater., 32: 281-9(Sept.-Oct. 1969). (In German).

The mixed nitride phases (U, Y)N, (U, La)N and (U, Pr)N were prepared either by arc melting in nitrogen atmosphere (3 atm) and subsequent homogenization or long-time annealing of powder mixtures. Lattice parameter variations in the systems UN–LaN and UN–PrN as well as x-ray and metallographic studies in the system UN–YN indicate that these phases are completely miscible. Complete miscibility between UN and all the rare earth nitrides is probable. The stability of the nitrides UN, PuN, YN, LaN, and CeN is briefly discussed. (auth)

46142 STRUCTURE OF ZIRCONIUM ANODIC OXIDE AND ITS ALLOYS. Alessandrini, G. (Consiglio Nazionale delle Ricerche, Milan); Dassu, G.; Peruzzi, R. Energ. Nucl. (Milan), 16: 566-79(Sept. 1969).

The morphology evolution in anodic oxides grown on Zr reactor grade (RG) and Zircaloy-4, with the change of the electrolyte bath chemical nature (1% KOH, 0.5 M H_3PO_4 and Banter's baths), of cell parameters, and of the base material composition was investigated. The investigation was carried out by optical, electronic and scanning microscopes, as well as by electronic diffractor. The comparison between morphological results and those, reported in the literature, relevant to thermal oxides, led to the conclusion that they do not differ essentially. There are however morphological differences between oxides grown on Zr RG and oxides grown on Zircaloy-4 (especially if the latter has been thermally treated, with migration of precipitates). (auth)

46143 RELATIONS BETWEEN THE SOLID STATE PHASES IN THE SYSTEMS CeO_2–MgO–CaO, CeO_2–MgO–BeO, CeO_2–MgO–SrO, CeO_2–MgO–BaO, CeO_2–CaO–BaO. Cocco, Antonio; Podda, Liliana (Univ., Trieste, Italy). Ann. Chim. (Rome), 59: 488-94(May 1969). (In Italian).

The solid state phase relations of the above-mentioned systems were examined over the temperature range 1400 to 1600°C by the static method using a combination of x-ray diffraction and reflected-light microscopic techniques. Stochiometric mixtures of CeO with the oxides BaO, CaO, SrO, MgO, and BeO (of purity greater than 99.5%) were heated for 300 hr in an oxidizing atmosphere at 1400°C. The experimental results enabled 7 isotherms to be constructed, which illustrate the phase relations of these systems. The phase diagrams are illustrated and are discussed. (BBB)

Radiation Effects

Refer also to abstracts 46088, 46089, 47338, and 47339.

46144 (BNWL–1144, pp 3.1-3) NUCLEAR GRAPHITE. Nightingale, R. E. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

The 100-eV yield of the radiolytic reaction of CO_2 and H_2 in a helium carrier decreases with CO_2 and H_2 concentration below 3500 ppM. At 350°C the G(CO) for the mixture is 1.9 molecules/100 eV at concentrations of CO_2 and H_2 above 3500 ppM. At H_2 and CO_2 concentrations of 300 ppM, the G(CO) is 1.5 and 0.65 molecules/100 eV, respectively. Design of an in-reactor creep experiment for graphites of interest to the Molten Salt Breeder Reactor is complete. The test is designed to measure in-reactor creep for graphite samples with a constant compressive load. This experiment is scheduled to begin in the ETR in October, 1969. (auth)

46145 (BNWL–1144, pp 4.1-2) HTGR GRAPHITE. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Measurements of the radiolytic reaction of graphite-water vapor are presently being carried out in a single-pass flow system. Product concentrations are very small, a few tenths of 1 volume parts per minute. CO_2 concentrations of the same magnitude in the helium carrier gas interfere with radiolytic yield determinations. (auth)

46146 (BNWL-SA-2412) VIBRATIONALLY COMPACTED CERAMIC FUELS. Freshley, M. D.; Burley, T. B. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Feb. 1969. Contract AT(45-1)-1830. 53p. (CONF-690323-2). Dep. CFSTI.

From Enlarged Halden Programme Group Meeting, Roeros, Norway.

Vibrationally compacted ceramic fuels have been irradiated in PRTR, EBWR, and commercial BWR's and PWR's to peak burnups of nearly 34,000 MWd/mtm. Irradiations in PRTR are being conducted at peak power generations of nearly 20 kW/ft with maximum fuel temperatures near melting. Peak burnups in PRTR are over 18,000 MWd/mtm. Fuel melting occurs in 86% TD vibrationally compacted UO_2–2 wt % PuO_2 fuel rods at a linear rod power of 655 ± 15 W/cm under PRTR conditions which is equivalent to a thermal conductivity integral value of 50 W/cm. In-reactor sintering and densification of the fuel cause restructuring to occur relatively rapidly during irradiation although time-temperature dependent sintering effects cause more subtle structural changes to occur. During extended exposures, data indicate that the in-reactor columnar grain growth temperature in pneumatically impacted UO_2–PuO_2 fuel is approximately 1800°C. The indicated sintering temperature is approximately 1700°C, although there is some apparently anomalous data that indicate the in-reactor sintering temperature may be as low as 1100 to 1200°C in high burnup fuel rods. The internal pressure in vibrationally compacted fuel rods during irradiation is less than expected although the rate of pressure buildup is consistent with predicted gas release fractions. Fission gas release is independent of burnup or burnup rate to peak burnups of nearly 10,000 MWd/mtm. The defect behavior or vibrationally compacted oxide fuel operating at heat ratings employed in power reactors has been satisfactory. There is some evidence which indicates that the defect behavior mode may change in the range of 800 to 900 W/cm with considerable fuel melting and could become the limiting criterion for advanced or very high power operation. Limited data on the transient behavior of vibrationally compacted fuels indicate that there may be significant differences between vibrationally compacted and pellet-containing fuel rods. There are indications that the failure modes of vibrationally compacted and pellet-containing fuels are different, although the failure threshold values are comparable, and that meltdown transients of vibrationally compacted fuels result in higher and more rapid pressure pulses than pellet-containing fuels. However, more data are needed to better define the transient behavior of vibrationally compacted fuels. (auth)

46147 (CEA-CONF-1297) ANALYSIS OF A SIMULATION OF IRRADIATED (U, Pu)O_2. Schmitz, Franz (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1963]. 5p. (CONF-690512-3). Dep. CFSTI (U. S. Sales Only).

From 71st Annual Meeting of the American Ceramic Society, Washington, D. C.

The post irradiation state of U, Pu mixed oxide nuclear fuel at 2% burnup has been simulated by mixing (U,Pu)O_2 with 25 inactive fission product elements. By sintering, dense pellets were obtained with a microstructure very similar to that of irradiated fuel. The stoichiometry of the simulated fuel has been measured and the oxygen pickup by metallic fission products has been evaluated. The lattice constants obtained from x-ray analysis of the final product could be explained quantitatively by the stoichiometry changes and the dissolution of soluble fission products in the matrix. The metallic inclusions as well as the matrix and an occuring grey phase have been examined using a microprobe analyzer. (auth)

46148 (GEAP–10042) POWER REACTOR HIGH PERFORMANCE UO_2 PROGRAM. Final Report, Progress Report No. 10, April 1–June 30, 1969. Ogawa, S. Y.; Lyons, M. F. (comps.) (General Electric Co., San Jose, Calif. Nuclear Fuels Dept.). June 1969. Contract AT(04-3)-189. 31p. (EURAEC–2121). Dep. CFSTI.

Work Performed under United States–Euratom Joint Research and Development Program.

A summary of activities during the entire program extending from 1966 to 1969 is presented. The objective of the program is to operate a significant number of UO_2 fuel rods with various degrees of central melting at rated power to high burnup in a commercial power reactor core. A chronology of activities is presented along with a list of prior reports issued. During the last quarter under the agreement, tests on Assembly D-50 were conducted. This assembly of UO_2 pellets was exposed at 5975 MWd/t. Results of post irradiation examination are summarized and interpretations of failure causes are offered. (J.R.D.)

46149 (WAPD-TM-628) BEHAVIOR OF AN INTENTIONALLY DEFECTED FUEL ROD WHICH RUPTURED DURING IRRADIATION (ROD BETT 79-64D) (LWBR DEVELOPMENT PROGRAM). Hersey, B. A.; Meieran, H. B. (Bettis Atomic Power Lab., Pittsburgh, Pa.). July 1969. Contract AT-11-1-GEN-14. 90p. Dep. CFSTI.

An intentionally defected Zircaloy-4 clad ceramic pelleted fuel rod (BETT 79-64D) was irradiated in the ETR reactor L-12 loop to a depletion of 8×10^{20} fissions/cc. This work was done as part of the LWBR/LSBR fuel element development program. This rod was intentionally defected with a 0.0062-inch diameter defect hole located near the top of the rod. The ZrO_2 + 29.6 wt % U^EO_2 fuel material in this rod was in the form of combined-void-volume pellets. The rod failed after 121.2 EFPD of test operation. The

purpose of the defect hole was to provide information regarding the effect of defect operation on the performance of a fuel rod with respect to cladding stability, waterlogging potentials, hydrogen pickup in the cladding, and corrosion behavior of an irradiated ceramic fuel material. The post-irradiation examination of this rod and evaluation of its irradiation behavior are described. (auth)

46150 ON THE PROTECTION OF UO_2, U, AND UC BY METAL FILMS AGAINST FISSION INDUCED LOSSES OF URANIUM. Gautsch, O.; Ruedl, E. (CCR-EURATOM, Ispra, Italy). J. Nucl. Mater., 32: 290-8(Sept.-Oct. 1969).

Pellets of UO_2, U, and UC, either bare or covered with thin films of nickel or gold were irradiated at thermal neutron doses of 0.2×10^{19} to 0.9×10^{19} n/cm^2, to determine by the collector method the ejection rates of uranium from their surfaces. The ejection rates found for bare emitters were comparable to those observed by other authors. The losses of uranium from the Ni-covered emitters were lower by a factor of 2 to 4, those of the Au-covered emitters were widely scattered. The ejected matter was deposited on carbon films in the form of spots (islands). The spot density and the size of the spots varied, depending on the nature of the emitting material and the distance of the carbon films from the emitter. (auth)

46151 INFLUENCE OF NUCLEAR RADIATION ON THE ELECTRICAL CONDUCTIVITY AND THERMO-ELECTRIC POWER IN THE UO_2–SiO_2 SYSTEM. Cojocaru, L. N. (Inst. for Atomic Physics, Bucharest). J. Nucl. Mater., 32: 346-50 (Sept.-Oct. 1969).

A study is made of the effect of fission fragments on the electric conductivity and thermo-emf of UO_2-SiO_2 system in the range 40 to 10 mol % UO_2. It is found that the conductivity decreases and that the thermo-emf increases after an irradiation of about 10^{16} fiss/cm^3. After annealing, it is noticed that the values of electric properties do not coincide with those before irradiation. The conductivity increases and the thermo-emf decreases. This is explained by assuming that the defects introduced into the UO_2-SiO_2 system are of two types: (a) Frenkel pairs and (b) uranium atoms and other atoms resulting from stopping of fission fragments in SiO_2 containing dissolved UO_2. Defects of the first type act as trapping centers for holes and the second type as acceptors. (auth)

46152 DETERMINATION OF THE OPERATING TEMPERATURE OF AN IRRADIATED FUEL ELEMENT BY MEANS OF DISPERSED MONITORS. Flipot, A. J.; Collignon, M.; Smolders, A. (Centre d'Etudes de l'Energie Nucleaire, Mol-Donk, Belg.). J. Nucl. Mater., 32: 268-80(Sept.-Oct. 1969). (In French).

A specific isothermal line can be precisely located in a compact of irradiated uranium dioxide, using the method of dispersed monitors. This technique depends on the use of alumina powder dispersed in the uranium dioxide and location of the eutectic radius corresponding to the 1915°C isothermal line. The addition of a small proportion of alumina does not affect the thermal conductivity of solid uranium dioxide but has a pronounced effect on the grain size and on the columnar structure. Results are presented of thermal simulation tests, and of irradiation experiments. The new method is briefly compared with the use of fusible metal wires and with the examination of the grain structure of pure uranium dioxide. The eutectic isotherm can be located to within about 0.1 mm. (auth)

Plastics and Other Materials

Refer also to abstracts 45306, 47170, and 47230.

46153 (NVO-38-17) EVALUATION OF MATERIALS AND TECHNIQUES FOR CEMENTING CASING IN LARGE DIAMETER DRILLED HOLES. Mathis, Gerald C. (Fenix and Scisson, Inc., Las Vegas, Nev. Fenix and Scisson, Inc., Tulsa, Okla. Petroleum Consultants, Houston, Tex.). Apr. 1969. Contract AT(26-1)-38. 68p. Dep. CFSTI.

Available literature, past performance, and projected ideas were reviewed, laboratory tests were conducted, and actual field tests were made to determine the most economical cement and placement equipment for cementing casings in large diameter holes to meet the basic criteria that the material must be strong enough to support the casing and to prevent venting of gaseous material to the atmosphere when a device is detonated at the bottom of the hole. Results showed that prehydrated gel cement (2 to 2.5% bentonite by weight of cement or water, respectively) is the most satisfactory for all large diameter holes at STS and at NTS in excess of 3,000 feet in depth. Under 3,000 feet at NTS, hole conditions must be studied to determine the value of using prehydrated gel cement in place of neat cement. In all instances, standard oil field well cementing equipment will be used for placement of the cement down hole. (auth)

46154 (ORNL-TM-2644) SOME THERMAL TRANSPORT PROPERTIES OF A LIMESTONE CONCRETE. Moore, J. P.; Graves, R. S.; Stradley, J. G.; Hannah, J. H.; McElroy, D. L. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 25p. Dep. CFSTI.

Heat conduction and stress analyses in concrete vessels require a knowledge of the thermal properties of the concrete. Measurements of the thermal conductivity, λ, and thermal diffusivity, α, on two limestone concrete specimens with densities of approximately 150 lb/ft^3 are reported. The effects of moisture content on λ were studied on a specimen air dried at room temperature and one dried during heating to 257°F. The former had room temperature values for λ, α, and Cp of 1.11 Btu ft^{-1} hr^{-1} °F^{-1}, 0.0274 ft^2/hr, and 0.274 Btu lb^{-1} °F^{-1}, respectively, at an age of 356 days with a moisture content of 4 wt %. The thermal conductivity of the concrete specimens increased with moisture content and density but appeared to be independent of temperature, except secondarily as the temperature affects moisture content. (auth)

46155 RADIATION RESISTANCE OF VARIOUS INSULATED WIRES AND CABLES. Morita, Minoru; Miyazawa, Kiyozumi (Showa Electric Wire and Cable Co., Kawasaki, Japan). Showa Densen Denran Rebyu, 19: No. 1, 69-75(Mar. 1969). (In Japanese).

Studies were made on the effects of in-pile radiation on the electrical and physical properties of insulated cables. Results on the radiation resistance of the insulators are discussed. It was found that chemically crosslinked polyethylene and low density polyethylene have excellent radiation resistance in a radiation environment of 10 R/hr. The electrical and physical properties of silicone rubber insulators were affected by high humidity in the radiation environment. (NSA of Japan)

PHYSICS (GENERAL)

Astrophysics and Cosmology

46156 EXTRA-TERRESTRIAL MATTER. Proceedings of a Conference at Argonne National Laboratory, March 7–8, 1968. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969. 348p. $12.50. (CONF-680329).

Fourteen papers on research in extra-terrestrial matter and related topics are presented. Areas covered include meteorites and tektites, lunar science, cosmic rays, cosmic rays and atmospheric neutrons, comets, and interstellar dust. Separate abstracts were prepared for eleven of the fourteen papers. (W.D.M.)

For abstracts of individual papers see: 46157, 46186, 46231, 46241, 46242, and 46304–46309.

Cosmic Ray Exposure Ages

46157 COMPOSITION OF STONY METEORITES. Mason, Brian. pp 3-24 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

Studies of meteorites suggest that they are samples of material which crystallized at a very early stage in the development of the solar system. It is proposed that in the pre-planetary stage of the solar system they crystallized shortly after the last stage in nuclear synthesis. The mineralogy and structure of the chondrites indicate a variety of formation conditions. The structure of enstatite chondrites indicates crystallization at temperatures as high as 1500°C, whereas the hydrates in carbonaceous chondrites show formation under cold and humid conditions. The general conclusion is that these meteorites represent samples from different regions of an ancestral solar nebula where the temperature ranged from very hot near the center to quite cold on the margins. The chondrites are an inhomogeneous aggregation of solid materials which may have never been completely melted, in contrast with the achondrites and stony-irons which appear to have originated in asteroids which grew large enough to melt or at least partially melt. Differentiation could have occurred by gravitational separation and fractional crystallization. Probably the chondrites came from bodies which never grew larger than about 50 km in diameter, whereas the achondrites and stony-irons came from rather large asteroids. (auth)

Stars

Refer also to abstracts 46655, 46677, and 46964.

46158 HYDROSTATIC INSTABILITY IN VERY HIGH TEMPERATURE STARS. Itoh, Naoki (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 41: 1211-16(May 1969).

Calculating the adiabatic exponent $\gamma \equiv (d \log P/d \log \rho)_{ad}$ or the nondegenerate gas consisting of radiation, neutrinos, electron pairs, muon pairs, pions, and nucleons, the condition of hydrostatic instability in high-temperature stars in the post-Newtonian approximation was investigated. It was found that the general relativistic effect plays a significant role for the hydrostatic stability condition of very high-temperature stars. (auth)

46159 CATALOG OF EMISSION LINES IN ASTROPHYSICAL OBJECTS. SECOND EDITION. Meinel, Aden B.; Aveni, Anthony, F.; Stockton, Martha W. Tuscon, Ariz., The University of Arizona, 1969. 201p.

One of the handicaps in the study and analysis of astrophysical emission objects is that the literature concerning the observation and identification of emission lines in astrophysical sources is so widely scattered. This volume represents an attempt to gather together the various publications, dating from 1930, that relate to these objects. The survey is complete to mid-1966. Included with the collected data on stellar spectra are data on contamination sources: airglow, city lights, aurorae, and lightning. Observed wavelength and identification and intensity tables are given. (W.D.M.)

46160 BINARY STARS AMONG CATACLYSMIC VARIABLES. X. PHOTOELECTRIC OBSERVATIONS OF EM CYGNI. Mumford, George S. (Tufts Univ., Medford Mass. Kitt Peak National Observatory, Tucson, Ariz.); Krzeminski, W. Astrophys. J., 18: Suppl. Ser. No. 166, 429-42(Aug. 1969).

Photoelectric observations of EM Cygni, suspected of being an old nova, are presented. The data, gathered since 1962, indicate that this star is an eclipsing binary with a period of 0.29090942 d. Primary eclipse appears to be partial, roughly 0.2 mag in depth. There is no evidence for a secondary minimum. Many features in the light curves are reminiscent of those found for such old novae and novalike variables such as Nova T Aur 1891 and U Gem. The star EM Cyg varies in brightness by about 2 mag in some 20 days. At maximum, the system is bluest as well as brightest in ultraviolet light. It seems likely that the greatest diminution of light at primary minimum may be attributed to an eclipse of a gaseous disk or shell surrounding one component. (auth)

46161 STATISTICAL MECHANICS OF STELLAR SYSTEMS. ter Haar, D. (Magdalen Coll., Oxford). J. Phys. Soc. Jap., 26: Suppl., 25-9(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

Various aspects of the evolution of stellar systems are considered briefly. The concept of relaxation times in stellar systems is discussed. (W.D.M.)

46162 THE SPECTROSCOPIC ORBITAL ELEMENTS OF ECLIPSING BINARY IZ PER = BV 224. Yavuz, I. (Hamburger Sternwarte, Hamburg). Astron. Astrophys., 2: 388-9(Aug. 1969). (In German).

The spectroscopic orbital elements of the eclipsing binary IZ Per = BV 224 = BD + 53° 323 = HD 9234 were calculated from 22 spectra (dispersion 72 Å/mm at Hγ). Only one component was spectroscopically perceptible. For the determination of the orbital elements the method of Wilsing and Russell was used. The results are the following: $V_0 = -41.2$ km/s, a sini = 2.69×10^6 km, e = 0.064, ω = 102.8°, $T = T_0 + 0.299^d$. (auth)

46163 ROTATIONAL PERTURBATION OF A RADIAL OSCILLATION IN A GASEOUS STAR. Simon, R. (Institut d'Astrophysique, Cointe-Sclessin, Belg.). Astron. Astrophys., 2: 390-7(Aug. 1969).

The perturbation method is applied to the problem of the oscillations of a gaseous star rotating around a fixed z axis according to a general law of the type $\Omega = \Omega(r,0)$. This rotation is assumed to be slow and the analysis includes all the effects in Ω and Ω^2, and particularly the rotational distortion of the stationary motion. The role of the trivial modes of oscillation of the zero order spherical star is emphasized, since these transversal and divergence-free modes which have a vanishing σ frequency appear to be important in the Ω^2 terms. The particular application to a radial mode is considered in detail and numerical results are given for a rigid rotation, in the case of the fundamental radial oscillation of the homogeneous and of the standard models. (auth)

46164 THE EFFECTS OF POLARIZATION ON DIFFUSION DESCRIPTIONS OF RADIATIVE TRANSFER. Pomraning, G. C. (Gulf General Atomic Inc., San Diego, Calif.). Astron. Astrophys., 2: 419-24(Aug. 1969).

The effect of a proper treatment of polarization in the equation of transfer is investigated, with particular emphasis on energy transport. It is found that for a large class of radiative transfer problems the neglect of the effects of polarization introduces a small error. The problems in this class are those that can be described by one of several diffusion equations, such as results from the widely used Eddington approximation. It is also found that the error associated with the neglect of polarization effects is comparable in magnitude to the error introduced due to the neglect of the anisotropy of the Rayleigh (Thomson) phase function. This suggests that if polarization effects are neglected, as is frequently the case in actual calculations of energy transport, it is not inconsistent to neglect the anisotropy of Rayleigh scattering as well. This observation has practical consequences since the equation of transfer is significantly easier to solve if the scattering phase function can be assumed isotropic. (auth)

46165 SHOCK PHENOMENA IN THE OUTER PART OF A STAR. Terauti, Ryutaro (Nihon Univ., Tokyo). Sendai Astron. Rap., No. 106, 70-93(Sept. 1968).

Taking the energy transport by radiation into account and assuming that the gas is completely ionized and the opacity is constant always and everywhere, the shock propagation and the resultant expanding motion in the outer part of a star are investigated, where the star is assumed to be represented by a polytrope with index n = 3 and the disturbance producing the shock wave is given at 0.8 radius of the star by the instantaneous increases in motion and/or radiation flux. These results are compared with those for

adiabatic cases. The propagation of the shock is approximately adiabatic and almost coincides with that given by the similarity solution in the inner layers, while in the outer layers it deviates from the adiabatic one and becomes somewhat similar to the isothermal case due to radiation loss of the shock energy. The expanding motion is also nearly adiabatic except in the early period for the surface layers, so that most of the disturbing energy is spent for the adiabatic expansion and only a few percent of the energy is lost by mass ejection. If $M_\odot$ and 1/7 $R_\odot$ are assumed as the stellar mass and radius and if the disturbing energy of about 10^{46} ergs is given, the mass of about 8×10^{28} grams is ejected, which is comparable with those obtained on the observation of nova phenomena. However, the calculated luminosity deviates considerably from that of nova star. It is plausible that this discrepancy is due partly to the neglection of the recombination processes of hydrogen. (auth) (NSA of Japan)

46166 DISTRIBUTION OF WOLF–RAYET STARS IN THE GALAXY, AND THEIR EVOLUTION. Mikulasek, Z. (Purkyne Univ., Brno). Bull. Astron. Inst. Czech., 20: 215-22(1969).

Three hypotheses of the formation and evolution of Wolf–Rayet stars are discussed. The decision, on the basis of the distribution of Wolf–Rayet stars in the Galaxy, as to which hypothesis comes closest to reality is facilitated by the fact that the age of such stars differs, according to these hypotheses, by as much as two orders of magnitude. The distribution of the number of Wolf–Rayet stars is evaluated in dependence on galactic latitude and longitude. Investigated is the relation between Wolf–Rayet stars and open star clusters, and the percentage of stars in physical connection with clusters is determined (21%). From their position with regard to clusters, the age of WN-type stars has been estimated at 3.2×10^6 years, and that of WC-type stars at 10.6×10^6 years. Discussed is the relation of Wolf–Rayet stars and O associations; the age of the stars in connection with them is estimated at 3.6×10^6 years. The agreements and differences in the distribution of Wolf–Rayet stars in the Galaxy and in the Large Magellanic Cloud are shown. It appears that the Paczynski's (1967, 1968) hypothesis is closest to reality if it is assumed, in addition, that stars with different initial masses pass through WN and WC-type phases of different duration. The region of avoidance is briefly discussed. (auth)

46167 SPHERES WITH TWO DENSITY DISTRIBUTIONS IN GENERAL RELATIVITY. Durgapal, M. C.; Gehlot, G. L. (Univ. of Jodhpur, India). Phys. Rev., 183: 1102-4(July 25, 1969).

Exact internal solutions were found in a massive sphere with two different density distributions. The density is a minimum at the surface and increases as we move towards the center; but the density in the central region is constant at a certain maximum value. The restrictions imposed by pressure-density relations limit the solutions to certain values of n for various ratios of core radius and external radius. n is the parameter expressing the densities in the two regions and the solutions of the field equations. (auth)

46168 EFFECT OF ATTRACTIVE NUCLEAR FORCES ON THE ONSET OF FERROMAGNETISM IN NEUTRON STAR MATTER. Clark, J. W.; Chao, N.-C. (Washington Univ., St. Louis). Nuovo Cim., Lett., 2: 185-8(Aug. 11, 1969).

Recently Brownell and Callaway (1969) explored the possibility of a ferromagnetic transition in pure neutron matter at a nucleon density somewhat greater than that corresponding to equilibrium of symmetrical nuclear matter under nuclear forces alone. Disregarding the attractive component of the nuclear interaction and assuming only a state-independent hard core, they predicted that the onset of ferromagnetism should occur in a region of density in which a reaction matrix treatment might be adequate. The purpose of this note is to point out that the effect of the attractive component of the nuclear interaction is to vitiate this conclusion. (W.D.M.)

46169 DETECTION OF INTERSTELLAR $H_2{}^{13}C^{16}O$. Zuckerman, B. (Univ. of Maryland, College Park); Palmer, Patrick; Snyder, Lewis E.; Buhl, David. Astrophys. J., 157: L167-71 (Sept. 1969).

The $1_{11}-1_{10}$ transition of interstellar $H_2{}^{13}C^{16}O$ has been detected in the direction of the continuum sources Sgr B2 and Sgr A and probably W51. Comparison with $H_2{}^{12}C^{16}O$ spectra obtained in these directions indicates the possible presence of regions of high ^{13}C abundance near the galactic center. The rest frequency of the $1_{11}-1_{10}$ transition was determined more accurately than in a previous laboratory measurement. (auth)

46170 PROTON–PROTON CYCLE IN STARS IN THE TEMPERATURE RANGE $10^7/5.10^7$ °K. Dergachev, V. A.; Kocharov, G. E. Kosm. Luchi, No. 10, 177-96(1969). (In Russian).

The problem of the proton–proton cycle in the interior of stars is investigated. The concentrations are calculated of the particles participating in the p–p cycle, dependent on the hydrogen and helium content. The reaction times of the p–p cycle are determined. The dependence of the quantity of energy released on the temperature and the chemical composition of the stellar substance is computed. (auth)

46171 EFFECT OF ELECTRON SCATTERING ON CURVES OF GROWTH. Rosendhal, Jeffrey D. (Univ. of Washington, Seattle. Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. Space Sci., 4: 419-26(Aug. 1969).

A new exact solution of the macroscopic line transfer equation including electron scattering terms was obtained for a Milne–Eddington model atmosphere, and curves of growth based on this solution were calculated. The results indicate that for lines formed by scattering there is a systematic change in the appropriate theoretical curve of growth as electron scattering becomes an increasingly important source of continuous opacity. In a case where electron scattering is the dominant opacity source, the abundance necessary to produce a given line strength may be decreased by a factor of 2 to 5 and the derived velocity parameter decreased by 20 to 30% due to the shifts in the theoretical curves. (auth)

46172 INTERPRETATION OF HYDROGEN RADIO RECOMBINATION LINES. Dyson, J. E. (Univ. of Manchester, Eng.). Astrophys. Space Sci., 4: 401-16(Aug. 1969).

Computations of the high-level populations of hydrogen in gaseous nebulae are used to compare observations of radio recombination lines with theoretical predictions based on possible line enhancement. Attempts to confirm the existence of maser action from electron temperatures derived on the assumption of thermodynamic equilibrium are inconclusive. There is evidence that most of the low ($\lesssim$5000 K) derived temperatures can be increased by at most a few percent by allowing for line enhancement. Measured ratios of the peak temperatures of lines of the same frequencies originating from different upper quantum levels, indicate maser action if Stark broadening is not taken into account. The inclusion of Stark broadening allows confirmation of maser action only in the central regions of the Orion Nebula in the case of the 137 β/109 α ratio, and in Orion, and, possibly, IC 1795 and M17, in the case of the 197 β/156 α ratio. (auth)

46173 NOVA VULPECULAE 1968 NO. 2 (KOHOUTEK). Rosino, L.; Chincarini, G.; Mammano, A. (Univ., Padua). Astrophys. Space Sci., 4: 392-400(Aug. 1969).

Nova Vul 1968 No. 2 (Kohoutek) was studied on Asiago material obtained before and after the announcement of discovery. The nova, fainter than 20 magnitude at minimum, brightened on July 16. The maximum (9.25 B) was reached on July 19. From the light curve the star can be classified as a normal fast nova. Objective prism spectra taken near maximum display the presence of absorption systems with radial velocities from −550 to −2200 km/sec. On slit spectrograms obtained at the end of October, the nova was found in the nebular stage with wide emission bands of H, He I, He II, N II, N III, and forbidden lines of O III, N II, and O I. The degree of excitation is slowly increasing. The nova is strongly reddened by interstellar absorption. (auth)

46174 FAR-ULTRAVIOLET SPECTROPHOTOMETRY OF BRIGHT STARS IN ORION. Stuart, Frank E. (Kitt Peak National Observatory, Tucson, Ariz.). Astrophys. J., 157: 1255-64(Sept. 1969).

A 12-inch telescope and low-resolution grating spectrophotometer were flown on an Aerobee rocket to obtain absolute vacuum-ultraviolet spectra of bright stars in Orion. Nineteen stars, including the Trapezium, were observed in the spectral range 1050 to 2180. A 55 Å region around Ly-α was purposely occulted to reduce the background due to geocoronal Ly-α light and to test for diffuse sources. The data shortward of Ly-α are not absolute, but are useful for relative comparison between different stars. Absolute intensities were generally somewhat higher than those reported by others, although differences were within the error limits of the calibration. Agreement of observed spectra with a B1.5 V model was generally good. A rapid divergence for wavelengths below 1800 Å between observed data for an A3 star (β Eri) and a model was noted. Variation of the general slope of the spectra of the earlier-type stars with luminosity class can be observed. A large ultraviolet excess was found for 42 Ori and probably for BS 1923. Evidence is presented to indicate that in 42 Ori the excess is probably due to a diffuse glow around the star. (auth)

46175 THE PRECESSION AND NUTATION OF DEFORMABLE BODIES. III. Kopal, Zdenek (Boeing Scientific Research Labs., Seattle). Astrophys. Space Sci., 4: 427-58(Aug. 1969).

In preceding papers of this series (Kopal, 1968; 1969) the Eulerian equations were set up which govern the precession and nutation of self-gravitating fluid globes of arbitrary structures in inertial coordinates (space axes) as well as with respect to the rotating-body axes, with due account being taken of the effects arising from equilibrium as well as dynamical tides. The explicit form of these equations is recapitulated for subsequent solutions. The coplanar case (in which the equation of the rotating configuration and the plane of its orbit coincide with the invariable plane of the system) is discussed; and small fluctuations in the angular velocity of axial rotation arising from the "tidal breathing" in eccentric binary systems are investigated. The angular velocity of rotation about the Z′ axis is considered to be constant, but finite inclination of the equator to the orbital plane is allowed for. The differential equations governing such a problem are set up exactly in terms of the time-dependent Eulerian angles θ and ϕ, and their coefficients averaged over a cycle. These equations are linearized by the assumption that the inclinations of the equator and the orbit to the invariable plane of the system are small enough for their squares to be negligible; and the equations of motion reduced to their canonical form. The solution of these equations—giving the periods of precession and nutation of rotating components of close binary systems, as well as the rate of nodal regression which is synchronized with precession—are expressed in terms of the physical properties of the respective system and of its constituent components. The results, in which the differences between the precession and nutation of rigid and fluid bodies are pointed out, are discussed. (auth)

46176 MODELS FOR MAIN-SEQUENCE STARS. Horn, J.; Kriz, S.; Plavec, M. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 193-201(1969).

Evolutionary model sequences are computed for stars of 2, 3, 4, 5, 6, 7, and 9 $M_{\odot}$, covering the phase of hydrogen burning in the star's core. Relations between various characteristics for the zero-age models are given, as well as for the top of the main-sequence expansion. Conditions are studied under which the star, if it happens to be the primary component of a binary system, becomes dynamically unstable during the main-sequence phase. Initial conditions for the process of mass exchange are derived. (auth)

46177 COMPARISON OF MAIN-SEQUENCE BINARIES WITH THEORETICAL MODELS. Kriz, S. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 202-14(1969).

Spectroscopic and photometric data are summarized on 26 eclipsing binaries for which the spectra of both components were observed. The absolute dimensions and masses of these binaries are newly computed. A comparison is made with Iben's (1967) and Horn's et al. (1969) theoretical models of main-sequence stars. For stars of smaller mass than 5 $M_{\odot}$ both series of models agree well with the binaries observed. Present observations of binaries do not permit a decision as to which of the used chemical compositions (X = 0.71 and X = 0.60) should be preferred. In the case of stars with a mass larger than 5 $M_{\odot}$, the theoretical models are overluminous in comparison with the binaries observed. (auth)

Quasi-Stellar, Radio, and X-Ray Sources

46178 (N-69-29863) PULSED X-RAY EMISSION OF NP 0532 IN MARCH 1968. Boldt, E. A.; Desai, U. D.; Holt, S. S.; Serlemitsos, P. J.; Silverberg, R. F. (National Aeronautics and Space Administration, Greenbelt, Md. Goddard Space Flight Center). June 1969. 10p. (NASA-TM-X-63582; X-611-69-245). CFSTI.

A measurement of the pulsed x-ray emission associated with the pulsar NP 0532 in the Crab Nebula is recorded. This information was obtained with a six-element detector flown onboard an Aerobee 150 rocket from White Sands, N. M., which was launched on March 16, 1968 at 03:15 UT. The NP 0532 is the only known pulsar to have detectable emission extending from the radio band to energies exceeding 30 keV. This measurement is one of the two existing that can provide information concerning the history of NP 0532 prior to its discovery in the radio and optical band. Since the energy output of this object is generally accepted to have as its origin the dissipation of rotational energy, knowledge of the period of pulsation as a function of time is of special interest. (auth) (STAR)

46179 SEARCH FOR MICROWAVE EMISSION FROM THE $^2\pi_{\frac{1}{2}}$, $J = \frac{3}{2}$ STATE OF OH. Turner, B. E. (National Radio Astronomy Observatory, Green Bank, W. Va.). Astron. Astrophys., 2: 453-7(Aug. 1969).

A search for three of the four microwave lines in the $^2\pi_{\frac{1}{2}}$, $J = \frac{3}{2}$ excited state of OH has established upper limits of ~ 0.3 f.u. for the lines in emission in the direction of the 18 cm OH sources in W 3, W 28, Ori A, NML Cyg, CIT 3, and CIT 7. None of the pumping mechanisms for anomalous OH excitation predict detectable emission or absorption from this state, within the limits of the search. (auth)

46180 THE RADIOSPECTRA OF A HOMOGENEOUS SAMPLE OF 4C RADIOSOURCES. Fanti, C.; Fanti, R.; Londrillo, P.; Padrielli, L. (California Inst. of Tech., Pasadena. Laboratorio Nazionale di Radioastronomia, Bologna). Astron. Astrophys., 2: 477-83(Aug. 1969).

Using observations at 178, 408, and 1420 MHz, the radio spectra of 136 sources in the declination range 29°30′ to 34°30′ of the 4C catalogue were determined. From observations at 1420 MHz, it is clear that the spectra of many sources flatten at frequencies below 408 MHz. There is evidence that this effect is more marked for sources with small angular diameter. (auth)

46181 RELATIVISTIC BEAMING OF RADIATION FROM PULSARS. Smith, F. G. (Univ. of Manchester, Eng.). Nature (London), 223: 934-6(Aug. 30, 1969).

The observations that CP 0328 radiates single pulses which appear to be basic elements of the total radio emission, and which are highly polarized, led to the suggestion that the mechanism was that of synchrotron radiation, giving a radiation beam which swept across the observer as the source rotated. The shape of the elementary pulse, and the pattern of polarization across the pulse, were very similar to the angular distribution of radiation from a highly collimated beam of electrons, and it was suggested that the ratio of the pulse duration to the period of the pulsar would provide a measure of the beam width, and hence a measure of the energy of the electrons. On this hypothesis the width and polarization of the pulse would be expected to change with radio frequency. No such change in the elementary pulses from CP 0328 was found in the studies described. Variations in beam width and polarization to be expected on the hypothesis of synchrotron radiation from electrons with high relativistic energies are discussed, and this mechanism is found to be unsatisfactory. It appears necessary to attribute the beam width to a geometrical effect which acts independently of frequency, and it is suggested that the radiation mechanism is isotropic and that the beam effect is due solely to a relativistic effect of the rapid rotation of the source. The pulses are observed to be highly polarized, in general with an elliptical polarization which changes smoothly through the duration of any one pulse, and it is supposed that the source radiates with an elliptical polarization varying smoothly over a 2π solid angle centered on the direction of the observer. The polarization could then be plane in this direction and circular perpendicular to it, or a rotation of the whole system could bring circular polarization into the direction of the observer. The only familiar system which matches this pattern is the cyclotron radiation from nonrelativistic electrons in a well-oriented magnetic field. Difficulties in adopting the cyclotron theory lie in the wide spectrum and high field strength of the radiation, but ways of meeting these difficulties are discussed. It must be supposed that the magnetic field differs in strength over the excited region sufficiently to cover the rf spectrum, and a range of at least 10 to 1 is required for this. Measurements on CP 0328 are reported, from which it is suspected that the simple cyclotron theory does not provide a sufficient explanation, and a nonlinear theory must be developed to account for the high radiated field strengths. (UK)

46182 PULSARS. Smith, F. Graham (Univ. of Manchester, Eng. Radio and Space Research Station, Slough, Eng.). Sci. J., 5: No. 6, 32-40(June 1969).

The astronomical objects recently discovered which emit regular pulses of radio waves are thought to be neutron stars. Measuring perhaps only 15 km in diameter they are composed almost entirely of neutrons and are revealing important new information about the universe. (auth) (UK)

46183 COHERENT MECHANISMS OF RADIO EMISSION AND MAGNETIC MODELS OF PULSARS. Ginzburg, V. L.; Zheleznyakov, V. V.; Zaitsev, V. V. (Lebedev Inst. of Physics, Moscow. Gorky State Univ., USSR). Astrophys. Space Sci., 4: 464-504 (Aug. 1969).

This paper is primarily concerned with the questions of models and the mechanisms of radio emission for pulsars, the polarization of this radiation, and related topics. For convenience and to provide a more complete picture of the problems involved, a short summary of the data on pulsars is also given. (TSS) (auth)

Solar Phenomena

Refer also to abstracts 46309, 46326, and 46678.

46184 SOLAR-TERRESTRIAL PHYSICS: SOLAR ASPECTS. Proceedings of Joint IQSY/COSPAR Symposium, London, July 17–22, 1967. Part I. Stickland, A. C. (ed.). Annals of the IQSY. International Years of the Quiet Sun. Volume 4. Cambridge, Mass., Massachusetts Institute of Technology Press, 1969. 422p. $19.50. (CONF-670729-(Vol.4)).

The range of subjects covered in this volume includes solar phenomena, interplanetary space, cosmic radiation, radiation belts, aurorae, and airglow. Separate abstracts were prepared for 24 of the 25 papers included. (W.D.M.)

For abstracts of individual papers see: 46217–46222, 46313–46321, and 46397–46405.

46185 ON THE SPECIAL EVENTS OF MARCH 1966. CORRELATION BETWEEN SOLAR AND TERRESTRIAL PHENOMENA. Ballario, M. C. (Osservatorio Astrofisico di Arcetri, Florence). Ann. Geophys., 25: 135-46(Jan.-Mar. 1969).

The solar and terrestrial phenomena observed in the period March 12 to April 4, 1966, were examined. In some cases a correlation is found between central-meridian passages of particular recurrent plages (not associated with eastern spot-groups type C, D, E...) and geomagnetic storms, aurorae, ionospheric F-layer disturbances, etc. In other cases the geomagnetic and terrestrial phenomena are associated with proton flares of importance 2 and with an importance 3 flare. (auth)

46186 COMETARY NUCLEI. Delsemme, Armand H. pp 304-16 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

Cometary nuclei could be the last remaining samples of the early composition of the solar system. The "dirty snowball" model still appears to be the best approach to their understanding. However, the observed lifetimes of the unknown "parents" of the identified radicals cannot be reconciled so far with likely molecules. It is suggested here that these lifetimes could be the lifetimes of the ice grains removed from the nucleus by evaporating gases. (auth)

46187 INVERSION OF THE INTENSITY INTEGRAL FOR THE DOPPLER CORE OF STRONG SOLAR ABSORPTION LINES. Worrall, G.; Wilson, A. M. (The Observatories, Cambridge, Eng.). Astron. Astrophys., 2: 458-68(Aug. 1969).

It is shown that intensity integral, considered as an equation for the profile in the Doppler core of strong solar absorption lines, can be inverted to obtain the line source function. Numerical methods for performing the inversion in the general case in which the absorption coefficient (Doppler width) varies with depth are described. (auth)

46188 AN ANALYSIS OF THE SOLAR SODIUM D LINES. Wilson, A. M.; Worrall, G. (The Observatories, Cambridge, Eng.). Astron. Astrophys., 2: 469-76(Aug. 1969).

Waddell's observations of the D lines in the solar spectrum were analyzed by a direct inversion of the line profiles. The principal conclusion is that the line source function in the Doppler core is significantly frequency-dependent. (auth)

46189 REVISED SOLAR IRON ABUNDANCE AND ITS INFLUENCE ON THE PHOTOSPHERIC MODEL. Garz, T.; Holweger, H.; Kock, M.; Richter, J. (Univ., Kiel). Astron. Astrophys., 2: 446-50(Aug. 1969). (In German).

Using the new f values of Garz and Kock (1969), an analysis of 26 photospheric Fe I lines was carried out yielding a solar iron abundance $\log \epsilon(\mathrm{Fe}) = 7.60$ ($\log \epsilon(\mathrm{H}) = 12$). This new value—10 times greater than recently determined photospheric values—is a consequence of the revised scale of f values and agrees with coronal abundance determinations. As a by-product it was found from the dependence of abundance on equivalent width, that in the solar model of Holweger (1967), the microturbulence has to be decreased by 0.7 km/sec, which leads to 1.0 km/sec at $\tau_{5000} \sim 0.1$. In order to obtain the same central intensities of Fraunhofer lines the macroturbulence must be increased to about 1.6 km/sec. At any depth $\tau_{5000} \leq 0.2$ in solar-type stars, the increase of $\epsilon(\mathrm{Fe})$ by a factor of 10 leads to an increase of the electron pressure by $\Delta \log P_e = 0.1$ and to a corresponding decrease of the gas pressure by the same amount. In the uv, especially in the range 1700 to 2300 Å, iron (together with magnesium and silicon) becomes an important source of continuous opacity. Thus, like Mg and Si, Fe will affect radiative-equilibrium models of stellar atmospheres. (auth)

46190 ATMOSPHERIC TRANSMISSION AND SOLAR SPECTROSCOPY IN THE SUBMILLIMETER WAVELENGTH RANGE. Biraud, Y.; Gay, J.; Verdet, J. P.; Zeau, Y. (Observatoire, Meudon, France). Astron. Astrophys., 2: 413-18(Aug. 1969). (In French).

The spectrum of the solar radiation between 300 μ and 1 mm wavelengths was studied and it was deduced by continuation of the Bouguer's line, that the atmospheric transmission was about 30% in the 300-μ window. The presence of a new absorption at 26 cm^{-1} noticed by Gebbie et al. (1968) was observed, and it is shown that it had an extra atmospheric and probably solar origin proved either by the mean of a Bouguer's continuation or by comparison of Sun and Moon spectra taken with the same resolution. Several lines due to the atmospheric absorption of O_2, O_3, N_2O, and perhaps D_2O, NO_2 were identified. (auth)

46191 OBSERVATION OF PROFILES AND ASYMMETRY OF FRAUNHOFER LINES. Boyer, R. (Observatoire, Meudon, France). Astron. Astrophys., 2: 375-80(Aug. 1969). (In French).

By means of spectrophotoelectric techniques the profiles of four neutral titanium lines (4534, 4562, 5210 and 5238 Å) already observed photographically by Lefevre and Pecker were recorded; in the earlier analysis these profiles were considered to be symmetric each time they were used for microturbulence–velocity determinations in the solar photosphere. The relative central intensities, r_0, derived from the measurements were compared to those obtained by Mohler or Waddell who were working with a double-pass spectrograph. It was found that the r_0 values are characterized by important fluctuations, and are also strongly affected by the apparatus function. After having computed the probable errors dr_0 related to the r_0 measurements it is pointed out that the real dispersion, σ, resulting from the data are several times greater than dr_0. On the other hand, statistical computations were made in order to find the uncertainty, dx, involved in the abscissac measurements of each experimental point belonging to the asymmetry curves of the titanium lines, and to obtain their dispersion σ. Finally, it was found that σ is about ten times greater than dx. These results show that the titanium profiles are disturbed by space-time fluctuations. (auth)

46192 INVESTIGATION OF INTERPLANETARY DUST BY MEANS OF ASTRONOMICAL OBSERVATIONS OF ZODIACAL LIGHT AND SPACE PROBES. Elsaesser, H. (Landessternwarte, Heidelberg-Koenigstuhl). Naturwissenschaften, 56: 169-74(Apr. 1969). (In German).

Optical observations of the zodiacal light and its brilliance are reported. The interpretation of these data on the density of interplanetary dust is described. Measurements on the density and composition of this interplanetary dust on the basis of space probes are also discussed. (J.S.R.)

46193 FURTHER INVESTIGATIONS OF SOLAR X-RAY SOURCES USING D-LAYER IONIZATION BEHAVIOR DURING ECLIPSES. Meisel, David D. (Leander McCormick Observatory, Charlottesville, Va.). Solar Phys., 8: 477-90(Aug. 1969).

Radio absorption records obtained in or near the zone of totality at two solar eclipses (May 30, 1965 and July 20, 1963) were examined in detail. It is concluded that all major radio absorption changes during an eclipse are ionization controlled and occur in the D–E layer. Corrections for the ultraviolet sensitivity of the region below 150 km were applied, so the results indicate effects attributable to the x-ray flux alone. The residual curves clearly show a "threshold" effect similar to that described by Rastogi et al., (1956) and later by Schmidt and Sharp (1965). Arguments are presented for interpreting this effect in terms of limb configurations involving small, hot x-ray sources similar to that described previously (Meisel, 1968). Once again it is necessary to postulate that grazing incidence reflections from the lunar limb occur. Source positions were derived from intersections of lunar arcs as seen from different geographic locations. So far, a total of five sources have been identified with reasonable certainty for three eclipses. All the source positions fall within the zones of maximum coronal x-ray intensity predicted by Elwert (1961). Except for one source located very close to the solar limb, all have positions which are well correlated with optical plages. Wien temperatures have been derived from the lunar reflection trends. These show a pronounced correlation with the relative strengths of the λ5303 (Fe XIV) and λ6374 (Fe X) corona near the source locations. Only the strongest and highest temperature sources correlate well with coronal white light structure. (auth)

46194 FOURIER SPECTRUM ANALYSIS OF LONG SAMPLES OF SOLAR LINE OSCILLATIONS. Gonczi, G.; Roddier, F. (Faculte des Sciences, Nice. Kitt Peak National Observatory, Tucson, Ariz.). Solar Phys., 8: 255-9(Aug. 1969).

Sequences of the oscillations of solar lines up to 2 hours 20 min

long were recorded at the same point on the Sun. The power spectra show several peaks separated by 0.85×10^{-3} cps on average from each other. A sharp main peak at 3.3×10^{-3} cps (300 sec period) is almost always present. These results suggest that the lifetime of the phase of the oscillation is much longer than that of the amplitude and is likely to exceed one hour. The modulation of a wave in smaller wave trains about 11 min long and 20 min apart (average values) are actually observed. Observations with low spatial resolution also suggest that the area of coherence is much greater for the phase than for the amplitude. (auth)

46195 ZEEMAN EFFECT FOR WEAK MAGNETIC FIELDS. Stenflo, Jan Olof (Astronomical Observatory, Lund, Sweden). Solar Phys., 8: 260-3(Aug. 1969).

The polarization of a normal Zeeman triplet is discussed for the case in which the lifetime τ of the excited state of the atom is comparable to or shorter than the period of Larmor precession. (auth)

46196 ABOUT THE INFLUENCE OF INHOMOGENEITIES OF MAGNETIC FIELDS ON LINE CONTOURS AND MAGNETOGRAPHIC MEASUREMENTS. Staude, J. (Heinrich-Hertz-Institut fuer Solar-Terrestrische Physik, Potsdam, Ger.). Solar Phys., 8: 264-70(Aug. 1969).

The discrepancies between theoretical and experimental calibration curves for solar magnetographs (Severny, 1967) may be explained by horizontal inhomogeneities of the observed but not resolved magnetic field region. Using the Unno solution of the equations of transfer simple two-stream models have been constructed. For the more complicated case of a depth dependence of the magnetic field vector it is shown assuming pure absorption and permitting arbitrary variations of the magnetic field vector and the atmosphere model with depth that a solution of the equations of transfer may be found by iteration. (auth)

46197 ON THE PSEUDO-π-COMPONENT IN SUNSPOT SPECTRA. Goehring, Rainer (Fraunhofer Institut, Freiburg i. B.). Solar Phys., 8: 271-4(Aug. 1969).

The visibility, contrast, and displacement of the pseudo-π component of a Zeeman triplet, explained as due to saturation, is computed for the triplet at 5250 Å (Fe I). Examples of the computational results are given. (auth)

46198 MODEL FOR THE PENUMBRA OF SUNSPOTS. Moe, O. Kjeldseth; Maltby, P. (Univ. of Oslo). Solar Phys., 8: 275-83(Aug. 1969).

A penumbra model in hydrostatic equilibrium is presented. The model accounts for the continuum observations as well as the observations of Fraunhofer lines in the penumbra. The uncertainty in the model in deeper layers is discussed. It is shown that the penumbra is probably not in strict radiative equilibrium. (auth)

46199 ON THE POSITION OF SUNSPOTS IN THE CORE OF Hα RELATIVE TO THE CONTINUUM. Engvold, Oddbjoern (Univ. of Oslo). Solar Phys., 8: 284-90(Aug. 1969).

The relative position of sunspots as observed in the core of Hα and in the continuum was studied in 316 spectra of 84 different sunspots. It was found that chromospheric features surrounding sunspots may produce apparent shifts of the spots in the core and in the wing of Hα. In addition, a shift directed towards the limb was found. This shift was found to be a height effect. The difference in height between the levels of the Hα core and the continuum varied from 2300 to 1000 km for different sunspots. (auth)

46200 GEOMETRICAL HEIGHT-SCALE AND THE PRESSURE EQUILIBRIUM IN THE SUNSPOT UMBRA. Mattig, W. (Fraunhofer Institut, Freiburg i. B.). Solar Phys., 8: 291-309 (Aug. 1969).

Spectra of spots very near to the solar limb (limb distance $\approx 8''$) are used to determine the height difference between the levels of formation of the continuum and the line cores of 60 medium-strong Fraunhofer lines. For all lines (with Rowland Intensity <10), this difference is <1" (= 735 km) and well correlated with the Rowland intensity. The line absorption coefficient is calculated for some lines with known oscillator strength. This gives a possibility to deduce a value for the scale height of the umbra, which is found to be about 100 km, thus being equal to the photospheric scale height. Pure hydrostatic equilibrium exists, therefore, in the umbra, and vertical magnetic forces are negligible. Other methods for determining the scale height are discussed for comparison. The horizontal pressure equilibrium is discussed by taking into account the Wilson effect, and by neglecting dynamic terms (flow of matter). The magnetic field is confirmed to be force-free in higher layers (chromosphere). The umbra–photosphere pressure difference increases towards deeper layers, having a maximum at $\tau^* \approx 1$ which corresponds to about two times the magnetic pressure $H^2/8\pi$. If rotational symmetry of the field is assumed, this can be explained by a minimum radius of curvature of the field lines of $\frac{1}{4}$ spot radius. (auth)

46201 GENERAL MAGNETIC FIELD AND ROTATION OF THE OUTER LAYERS OF THE SUN. Unz, F.; Walter, K. (Univ., Tuebingen, Ger.). Solar Phys., 8: 310-15(Aug. 1969).

How the rotation of the outer layers of the Sun will be influenced by a variable general magnetic field was investigated. Applying the resulting formulae to the spectroscopic observations of the velocity of rotation at the solar limb in middle and high latitudes, the variation of the rotational velocity during the cycle 1901–1912 as found by Newall and by Halm can be made to agree with modern views on the general magnetic field. (auth)

46202 ROSSBY-WAVE DYNAMO FOR THE SUN. I. Gilman, Peter A. (Univ. of Colorado, Boulder). Solar Phys., 8: 316-30(Aug. 1969).

There is increasing interest in the possible existence of large horizontally flowing eddies or "Rossby waves" in the Sun's convection zone and photosphere. A mathematical model is presented which shows that flows of this type, driven by an assumed latitudinal temperature gradient, can act as hydromagnetic dynamos to induce magnetic fields that periodically reverse. The assumptions for the model are discussed, earlier linear analyses that demonstrate the ability of Rossby waves to induce solar-like magnetic fields are reviewed, and the nonlinear equations that govern the model are derived. The analysis is simplified by confining the fluid and magnetic fields to a thin rotating annulus. The flow is taken to be nearly incompressible, heliostrophic, and hydrostatic. Induced magnetic fields are allowed to react upon the inducing motions. Transports of momentum and magnetic flux by smaller scale convective motions, and the transport of heat by these motions and radiation, are parameterized by diffusion coefficients. The solar convection is also assumed to be responsible for the latitudinal temperature gradient. (auth)

46203 OBSERVATION OF SOLAR RADIO EMISSION BY THE 22-m RADIO TELESCOPE AT THE CRIMEAN ASTROPHYSICAL OBSERVATORY AT 2,25 mm AND 8,15 mm WAVELENGTHS. Efanov, V. A.; Kislyakov, A. G.; Moiseev, I. G.; Naumov, A. I. (Crimean Astrophysical Observatory, Moscow, Gorky Univ., USSR). Solar Phys., 8: 331-40(Aug. 1969).

The results are given of observation of solar radio emission of the S-component at 8.15 and 2.25 mm made with the 22 m radio telescope of the Crimean Astrophysical Observatory. Solar radio images are obtained at both wavelengths. The data are presented of radio emission intensity and brightness temperatures of 10 sources of the S component as well as the result of a flare observed. The sources of the S component appear to be opaque at millimeter wavelengths. (auth)

46204 SOLAR FLARE OPTICAL, NEUTRON, AND GAMMA-RAY EMISSION. Lingenfelter, R. E. (Tata Inst. of Fundamental Research, Bombay). Solar Phys., 8: 341-7(Aug. 1969).

It has previously been suggested that the energy for the optical emission of solar flares was provided by ionization losses of accelerated particles in the flares. It is shown here that nuclear interaction of these particles would also produce fluxes of secondary neutrons and gamma rays detectable at the Earth. A comparison of the expected intensities of these secondaries with the present upper limit intensities during solar flares shows that such an origin from the optical emission energy is consistent with the measured limits. (auth)

46205 SOLAR SOFT X-RAYS AND SOLAR ACTIVITY. I. RELATIONSHIPS BETWEEN REPORTED FLARES AND RADIO BURSTS, AND X-RAY BURSTS. Teske, Richard G.; Thomas, Roger J. (Univ. of Michigan, Ann Arbor). Solar Phys., 8: 348-68(Aug. 1969).

Soft solar x rays ($8 \leq \lambda \leq 12$ Å) were observed from OSO-III. An analysis of the x-ray enhancements associated with 165 solar flares revealed that there is a tendency for a weak soft x-ray enhancement to precede the cm-λ burst and Hα flare. The peak x-ray flux follows the cm-λ peak by about 4 min, on the average. Additionally, it was found that flare-rich active centers tend to produce flares which are stronger x-ray and cm-λ emitters than are flares which take place in flare-poor active centers. (auth)

46206 EMISSION OF SOLAR X-RAYS IN THE 0,5 TO 3 A WAVELENGTH RANGE AND ITS RELATION TO THE MAGNETIC CONFIGURATION OF ACTIVE CENTERS. Chambe, G. (Meudon Observatory, France). Solar Phys., 8: 369-75(Aug. 1969).

The slowly varying component of solar x rays in the 0.5- to 3-Å wavelength range was studied, using data obtained by the satellite Explorer 30. The intensity of these x rays is poorly

correlated with the centimeter radio flux, contrary to the good correlation found in the spectral bands 1 to 8, 8 to 16, and 44 to 60 Å. On the other hand, the 0.5- to 3-Å x-ray intensity is often connected to the development of a specific magnetic configuration in the sunspot group, which may thus be associated with the x-ray-producing active center. (auth)

46207 SPECTRAL CHARACTERISTICS OF MEDIUM-SIZED SOLAR RADIO EVENTS. Fokker, A. D. (Utrecht Univ.). Solar Phys., 8: 376-87(Aug. 1969).

Peak intensities at different frequencies, as reported by several solar radio patrol stations, are used to study the spectrum at the time of maximum intensity of medium-sized solar radio events that cover both the centimetric and metric frequency bands. Two types of spectrum can be distinguished: a V type of spectrum, where the straight lines, that can be drawn to represent the centimetric and the metric branches, meet each other at a frequency somewhere in the decimetric frequency range and a jump type of spectrum, where a discontinuity occurs somewhere in the low-frequency part of the decimetric spectrum. The aspect of the radio response at 600 MHz may have a character that is more "centrimetric" or "metric." Its character tends to correspond to the spectral branch (metric or centimetric) to which, according to the spectrum, the 600-MHz burst belongs. It is concluded that the centimetric and the metric branch of a cm/m-event are largely independent of each other. It is suggested that a jump-type spectrum occurs if some conditions relating to the coronal magnetic field is fulfilled. (auth)

46208 TYPE III RADIO BURSTS IN THE OUTER CORONA. Alexander, J. K.; Malitson, H. H.; Stone, R. G. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys., 8: 388-97(Aug. 1969).

Type-III solar radio bursts observed from 3.0 to 0.45 MHz with the ATS-II satellite over the period April–October 1967 were analyzed to derive two alternative models of active region streamers in the outer solar corona. Assuming that the bursts correspond to radiation near the electron plasma frequency, "pressure equilibrium" arguments lead to streamer Model I in which the streamer electron temperature derived from collision damping time falls off much more rapidly than in the "average" corona and the electron density is as much as 25 times the average coronal density at heights of 10 to 50 $R_\odot$. In Model II the streamer electron temperature is assumed to equal the average coronal temperature, giving a density enhancement that decreases from a factor of 10 close to the Sun to less than a factor of two at large distances (>¼AU). When the burst frequency drift is interpreted as resulting from the outward motion of a disturbance that stimulates the radio emission, Model I gives a constant velocity of about 0.35c for the exciting disturbance as it moves to large distances, while with Model II, there is a decrease in the velocity to less than 0.2c beyond 10 $R_\odot$. (auth)

46209 ON A POSSIBLE PROTON ORIGIN FOR TYPE V CONTINUUM RADIATION FROM A SOLAR FLARE. Friedman, M. (Cornell Univ., Ithaca, N. Y.); Hamberger, S. M. Solar Phys., 8: 398-9(Aug. 1969).

Since it is known that proton fluxes are emitted, an attempt is made to estimate the energy and concentration needed by the protons if they are to account for the observed Type V radio emission from solar flares. (W.D.M.)

46210 COMMENT ON THE NOTE BY FRIEDMAN AND HAMBERGER. Svestka, Z. (Astronomical Inst., Ondrejov, Czech.). Solar Phys., 8: 400(Aug. 1969).

A proton origin for Type-III and Type-V radio bursts was suggested in the preceding note. An attempt is made here to show that space observations indicate a correlation of these radio events with the streams of electrons. (W.D.M.)

46211 COROTATING STRUCTURE IN THE SOLAR WIND. Carovillano, R. L. (Boston Coll.); Siscoe, G. L. Solar Phys., 8: 401-14(Aug. 1969).

The hydrodynamic equations which describe the radial solar wind expansion are linearized and specialized to treat corotating perturbations. Approximate solutions are found which are time stationary in the corotating reference frame. The solutions predict the behavior of corotating structures for a given condition close to the Sun. In particular, the structure resulting from the interaction of fast and slow streams is described. Comparison with sector structure data shows reasonable qualitative and quantitative agreement. (auth)

46212 NORTH-SOUTH ASYMMETRY IN THE SOLAR WIND. Siscoe, G. L.; Coleman, P. J. Jr. (Univ. of California, Los Angeles). Solar Phys., 8: 415-21(Aug. 1969).

The orientation of tangential discontinuities seen by Mariner 4 are interpreted as implying a sector-dependent asymmetry in the north–south component of the solar-wind flow. In two sectors, fast solar wind streams had a southward motion relative to slow streams, in one sector the reverse obtained, and in the remaining sector the asymmetry was not clearly defined. This is interpreted as being due to greater pressure in the northern hemisphere in two sectors and greater pressure in the southern hemisphere in one. It is possible this asymmetry could produce a small average southward magnetic-field component. (auth)

46213 HYDROMAGNETIC SHOCKS IN THE SOLAR WIND. Ogilvie, K. W.; Burlaga, L. F. (Goddard Space Flight Center, Greenbelt, Md.). Solar Phys., 8: 422-34(Aug. 1969).

The Rankine–Hugoniot relations are applied to shock-like discontinuities measured by both magnetic field and plasma instruments on the satellite Explorer 34 between May 30, 1967 and Jan. 11, 1968. Shock normals were either determined from the magnetic field observations, or from the times of occurrence of the discontinuity at Explorers 33, 34, and 35. The Rankine–Hugoniot relations are obeyed to the accuracy of the observations, and the values of shock velocities, density ratios, and Mach numbers indicate that at 1 AU the typical interplanetary shock is not strong, although all the events studied caused geomagnetic impulses. (auth)

46214 HELIUM ABUNDANCE IN THE SOLAR WIND. Ogilvie, K. W. (Goddard Space Flight Center, Greenbelt, Md.); Wilkerson, T. D. Solar Phys., 8: 435-49(Aug. 1969).

Observations of hydrogen and helium ions in the solar wind have been carried out by the Goddard Space Flight Center–University of Maryland plasma instrument on Explorer 34. These ions are completely separated by means of electrostatic and magnetic fields. The average value of the ratio of number densities is 0.051 ± 0.02, derived from over 3000 h of measurement. Variations about this value from about 0.01 up to greater than 0.15 occur, and there are more high values than can be explained by random variation. A tentative association with some geomagnetic storms is suggested. The above value of abundance, assuming that plasma emitted in the eclipse plane is a fair sample of the output of the Sun, combined with other recent work by other methods indicate that the solar abundance may be about half the previously quoted estimates of approximately 0.1. (auth)

46215 SOME FEATURES OF THE SOLAR MICROWAVE EMISSION AND THEIR CONNECTION WITH GEOMAGNETIC ACTIVITY. III. SUNSPOTS AND GEOMAGNETIC ACTIVITY. Roosen, J. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Solar Phys., 8: 450-63(Aug. 1969).

The distinction between faint and bright sources of the slowly varying component of the solar microwave emission is applied to statistics of the geomagnetic activity. Superposed epoch diagrams (current disturbances excluded) show that the increased number of disturbed days after the CMP of sunspot groups can almost exclusively be ascribed to the spot groups associated with faint sources. The variation of the disturbance amplitude with the heliographic latitude of the spot groups is discussed. A tentative model for the solar-wind enhancement associated with a faint source is presented. (auth)

46216 RECENT RESEARCH IN SOLAR MAGNETISM. von Klueber, H. (Cambridge Univ., Rabat, Malta). Scientia (Milan), 104: 107-21(Mar.-Apr. 1969).

Solar magnetic fields play an important role in the release of such corpuscular streams and in controlling their speed and direction through interplanetary space. In some instances where only one spot is visible, it is possible to find in the magnetic records a clear indication of a small magnetic field of opposite polarity, at the expected position of the other, but invisible, spot of the pair. These invisible spots are important in the study of solar-terrestial relations. Distribution of lines of magnetic force above a single spot in a simplified model is shown. The maximum sunspot strength occurs at the center of the spot, where the lines of force are perpendicular to the solar surface. Toward the edge of the spot the field strength decreases considerably and the lines of force become fanned out and inclined. The physical mechanism responsible for the local magnetic pattern can also be traced in other physical features of the Sun's surface. The bright H alpha and K regions, so well-known from spectroheliographic observations, in their distribution apparently follow closely the configuration of the magnetic pattern. Observations also suggest that there may be a small general solar magnetic field and that this may reverse with the cycle of sunspot activity. Some theories seeking to explain how solar magnetic fields are produced are discussed. (BBB)

46217 THE HISTORY AND MORPHOLOGY OF SOLAR ACTIVITY, 1964–1965. Dodson, H. W.; Hedeman, E. R. (Univ.

of Michigan, Pontiac). Ann. IQSY (Int. Years Quiet Sun), 4: 3-35(1969).
From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The level of activity and the time of minimum between solar cycles 19 and 20 are discussed. The principal intervals of solar calm and solar activity in 1964–1965 are identified and flare data are evaluated. The dates of birth of major centers of activity on the visible hemisphere are tabulated and a roughly five-month cadence in the occurrence of critical changes in solar phenomena in these years is pointed out. The latitude distribution of centers of activity is studied. Spots with latitudes and polarities appropriate for the old solar cycle continued to form throughout 1964–1965. New-cycle regions developed mainly in the northern hemisphere with a N–S asymmetry greater than that of the onset of any other cycle in the preceding 100 years. A graphical representation shows the longitude distribution of all major active centers for the period 1962–1966. For these years zones of activity much larger than single plages existed for long intervals of time. New-cycle activity developed in the longitude zones favored by old-cycle activity. 1964–1965 provided numerous instances when significant aspects of solar activity occurred during the same rotation on approximately opposite sides of the sun. (auth)

46218 ENERGETIC SOLAR RADIATIONS. Friedman, Herbert (Naval Research Lab., Washington, D. C.). Ann. IQSY (Int. Years Quiet Sun), 4: 36-56(1969).
From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

Sources of the Sun's ionizing radiations are primarily localized in active regions of the corona, overlying sunspots and plages. At sunspot minimum, activity centers are rare; the most energetic x rays disappear and only a low-base level of general coronal emission from the entire area of the disk remains. From mid-1964 to early 1966, the base level monitored in a band 8 to 20 Å rose an order of magnitude. The appearance of the first important activity center of 1966 raised the flux level (8 to 20 Å) more than a factor of 50. These changes are associated with increasing temperature and density. Typical of the general quiet corona is a temperature from 1.0 to 1.5×10^6 °K. Active regions, in the absence of flares, reach temperatures of several million degrees. Solar x-ray spectra exhibit evidence of nonthermal processes which indicate that acceleration processes are continuously operative to produce electrons with energies from the keV to the MeV range, even under "quiet" Sun conditions. (auth)

46219 ENERGETIC SOLAR PARTICLES. Parker, E. N. (Univ. of Chicago). Ann. IQSY (Int. Years Quiet Sun), 4: 57-61 (1969).
From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The several reasons for interest in energetic solar particles are reviewed, including general interest in acceleration mechanisms, solar abundances, interplanetary magnetic field configurations, and cosmic-ray propagation through interplanetary fields. Observations of magnetic fields and energetic particle motions are becoming sufficiently quantitative and precise to permit cross checking of the various diffusion coefficients deduced from solar and galactic cosmic-ray particle propagation. References to the basic papers in the literature are cited. (auth)

46220 ORIGIN OF THE SOLAR WIND AND ITS ASTROPHYSICAL ASPECTS. Mustel, E. R. (Astronomical Council, Moscow). Ann. IQSY (Int. Years Quiet Sun), 4: 67-87(1969).
From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The problem of the outflow of gases from the quiet Sun is reviewed. It is concluded that the solar corona is composed of two components: the first component (the streamers) is characterized by relatively low outward velocities and the second one (the solar wind itself) is characterized by relatively high velocities. Existing data about the structure of the solar corona do not confirm the hypothesis that the general magnetic field of the Sun is of dipolar character. Existing data confirm the model according to which each quasistationary corpuscular stream is an assembly of magnetic tubes, proceeding from an active region. The usual recurrent R disturbances are due to active regions in their optical–magnetic stage, while classical M disturbances are due to the final magnetic stage of the active region. It is concluded that certain processes of nonthermal origin take place at the base of quasi-stationary corpuscular streams. These processes evolve mainly in the corona within a rather extended volume, with center situated over the active region, but of dimensions greater than those of the active region. (auth)

46221 DIRECT MEASUREMENTS OF INTERPLANETARY MAGNETIC FIELDS AND PLASMAS. Ness, N. F. (Goddard Space Flight Center, Greenbelt, Md.). Ann. IQSY (Int. Years Quiet Sun), 4: 88-109(1969).
From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

Direct measurements on satellites and space probes since 1961 have demonstrated the existence of the solar wind, essentially as theoretically predicted by Parker. Typical values at 1 AU of the interplanetary magnetic-field are: 6 gamma average magnitude ranging between 2 and 40 gamma; flux values range from 10^8 to 10^{10} ions cm^{-2} s^{-1}. Additional first-order results suggest that the solar wind source is located at 10° to 25° north heliographic latitude and appears (at 1 AU) to come from approximately 1.5° east of the Sun, a direct result of co-rotation of the inner solar corona. Synoptic studies of physical properties have indicated a sectoring of the direction of the interplanetary magnetic field and correlated variations of plasma velocity, density, and temperature. Second-order results recently obtained reveal a fine-scale filamentary structure of the interplanetary magnetic field that directly connects to the Sun. Field-aligned thermal (or random velocity) anisotropies in the solar plasma are also observed. This paper reviews the quantitative results and the synoptic picture which has emerged of the extended solar corona as observed from 0.7 to 1.5 AU during the last six years by the Mariner, IMP, Pioneer, and Vela spacecraft. (auth)

46222 COMETS, INTERPLANETARY SPACE, AND THE PROBLEMS OF THE SOLAR SYSTEM. Vsekhsvyatskii, S. K. (Kiev State Univ.). Ann. IQSY (Int. Years Quiet Sun), 4: 110-18 (1969).
From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The number of comets now observed and the distribution of their paths in the solar system are sufficient to indicate the conditions in a wide region of interplanetary space. Brightness variations of comets are found to be related to the corpuscular structure of the outer corona; assuming electromagnetic interaction with the solar wind plasma, a study of the direction of Type I (curved) comet tails predicts a radial velocity of the interplanetary plasma that agrees with results obtained from Mariner 2. Comets are also important to the understanding of the origin and evolution of the solar system. There is need for an international service for comet astrophysical observations and for international cooperation with organizations concerned with interplanetary space and with geophysics. (auth)

46223 ON A POSSIBLE CONNECTION BETWEEN SOLAR ACTIVITY AND QUASI-PERIODICAL VARIABILITY OF THE GRAVITATIONAL CONSTANT. Kalitsin, Nikola. Izv. Fiz. Inst. Aneb, Bulg. Akad. Nauk., 18: 115-18(1969).

Starting with a generalization of the Einstein gravitational equations for vacuum in the case of the n-dimensional Riemannian space, the gravitational constant is found as a periodic or quasi-periodic function of $c_4 t_4 - r$, where c_4 is the velocity of light in vacuum, t_4 is the Einstein relative time, and r is a spherical coordinate. Such quasi-periodic changes of the gravitational constant can give an explanation of the quasi-periodic variations of the solar activity, and have an effect on the motion of bodies in the solar system. Thus the correlation between solar activity and some anomalous motions of Jupiter, Eros, Mercury, Venus, the Moon and the Earth is explained. (J.F.P.)

46224 STRUCTURE OF MAGNETIC HETEROGENEITY FLOWS FROM THE SUN ACCORDING TO THE DATA ON RECURRENT DISTURBANCES IN COSMIC RADIATION AND MAGNETIC ACTIVITY. Dorman, L. I.; Luzov, A. A.; Khrustselevskaya, G. V. Kosm. Luchi, No. 10, 156-61(1969). (In Russian).

A detailed study was made of the 27-day recurrent events in cosmic radiation intensity and geomagnetic activity (K_p) as observed during the period from July 11, 1957, to December 31, 1958. The linear filtration method was used for data analysis. The results concerning the floating period of the recurrent geophysical events are explained as caused by shifts of the center of corpuscular stream outbursts on the Sun and by changes in the structure of the streams themselves. This conclusion is corroborated by a direct comparison with the solar activity index expressed as the spot area in the central part of the disk. In connection with these results, the properties of the solar plasma streams causing the recurrent geophysical events are discussed. (auth)

46225 SOME FEATURES OF THE ENERGY SPECTRUM OF SOLAR COSMIC RAYS. Miroshnichenko, L. I. Kosm. Luchi, No. 10, 50-5(1969). (In Russian).

Some features of the energy spectrum of solar cosmic rays were analyzed. The role of various factors which determine the form of the spectrum near the Earth's orbit (drift, anti-Fermi deceleration, convective transfer, diffusion, prolonged emission from the acceleration region) were examined. A number of flares were taken as examples to show that experimental data deviate from the exponential law of the rigidity spectrum of solar particles suggested by Freier and Webber. Probable causes of this disagreement are discussed. (auth)

46226 THE ^{37}Cl SOLAR NEUTRINO EXPERIMENT AND THE SOLAR HELIUM ABUNDANCE. Iben, Icko Jr. (Massachusetts Inst. of Tech., Cambridge). Ann. Phys. (N. Y.), 54: 164-203 (Aug. 1969).

The preliminary upper limit of 3×10^{-36} counts per second per ^{37}Cl atom set by Davis, Harmer, and Hoffman in an experiment to detect solar neutrinos establishes a sensitive, nearly opacity independent, relationship between low-energy nuclear cross-section factors and an upper limit on the Sun's initial helium abundance. Using currently quoted values for the relevant cross-section factors and conventional assumptions regarding the Sun's makeup, consistency between theoretical estimates for the counting rate and the Davis, Harmer, and Hoffman limit can be achieved only if the Sun's initial helium abundance Y (^4He abundance by mass) is less than 0.16 to 0.20, surprisingly low when compared with values (Y = 0.25 to 0.30) which have previously been estimated for the Sun and for other objects in the Galaxy as well. A higher upper limit on the solar helium abundance is possible if one or more of the following is true: (1) One (or more) of the relevant nuclear cross-section factors lies beyond commonly quoted limits; (2) One (or more) of the relevant neutrino absorption cross sections has been overestimated; (3) The Sun did not condense out of a chemically homogeneous nebula and/or pass through a homogeneous phase; (4) The opacity near the solar center is such that the Sun possesses a large convective core; (5) Spin-down or meridional currents mix or have mixed matter over the entire solar interior on a time scale short compared to the age of the Sun; (6) The Sun is considerably younger than $4\frac{1}{2}$ billion years; (7) There are large-scale magnetic fields in the Sun with strength up to 10^9 gauss near the center; and (8) The gravitational constant increases with time. A lower limit on Y in the neighborhood of 0.15 to 0.18 is set by the choice of $4\frac{1}{2}$ billion years for the Sun's age. If, therefore, the eventual upper limit on the counting rate set by the Davis et al., experiment is reduced much below the preliminary limit, a clear discrepancy with conventional theory will be established, regardless of external arguments for higher Y. (auth)

46227 SOLAR WIND TAIL AND THE ANIOSTROPIC PRODUCTION OF FAST HYDROGEN ATOMS. Blum, P. W.; Fahr, H. J. (Univ., Bonn). Nature (London), 223: 936-7(Aug. 30, 1969).

It was suggested (Patterson et al., Planet. Space Sci., 11: 767 (1963)) that one half of the flux of the solar-wind protons is returned to the heliosphere at a shock front, somewhere between 5 and 50 AU from the Sun, in the form of fast neutral H-atoms produced in charge-exchange processes taking place in a thin shell around the shock front. This model was subsequently modified by the assumption that charge exchange occurs in a more extended region beyond the shock front, referred to as a transition region, and in this case less than half the solar-wind protons would be fed back as fast neutral atoms into the heliosphere, since the viewing angle by which the heliosphere is seen from an outer point of the transition region is smaller than a solid angle of 2π. Total conversion of solar-wind protons into fast neutrals in the transition region would mean that no subsonic expansion of the solar-wind corona by fast protons exists beyond the transition region; all the fast protons would become converted into slow protons and accumulated in the turbulent magnetic field. Some interesting problems arising from the conditions of continuity of neutral atoms and protons for the case of total conversion on which Patterson's model is based are discussed, involving inter alia that the influx of neutral interstellar hydrogen into the transition region would be highly anisotropic. The idea of a nearly spherical shock front is in accordance with the proposed "tail" model, but the shape of the transition region is highly aspherical. Some characteristics of the proposed transition region are presented. An anisotropic distribution of fast collision generated neutrals within the heliosphere is to be expected. (UK)

46228 DEVELOPMENT AND SPATIAL STRUCTURE OF PROTON FLARES NEAR THE LIMB AND CORONAL PHENOMENA. II. FLARE OF 26. IX. 1963 AND ITS EMISSION. Krivsky, L. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 163-71(1969).

From a series of photographs of a proton flare of the ascending-tube type of Sept. 26, 1963, in Hα, some further typical properties of proton flares were demonstrated. The length and the rate of elongation of chromospheric flare ribbons, the width and the height of the flare channel and the rates of its growth, the length of the channel according to the peak emission ribbon, and the width of this ribbon were investigated. The wave and particle emissions of the flare are briefly described. To conclude, the spatial dimensions of some of the stages and formations of the flare channel, significant for the release of energy in the form of accelerated particles and of x emission, are given. (auth)

46229 SOME NOTES ON BABCOCK'S THEORY OF SOLAR ACTIVITY. Kopecky, M. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 172-6(1969).

The change in the initial magnetic field of the Sun from cycle to cycle can explain, on the basis of Babcock's theory, the different shape of the course of the mean heliographic latitude of spots in the different 11-year cycles. This would also lead to changes in the magnetic field of the corona. If, as follows from the work of Godoli (1966) and Vostrý (1966), the form of the initial magnetic solar field $H_\varphi = H_0 \sec \varphi$ and the author's interpretation of butterfly diagrams (Kopecký, 1966) satisfy the observations better, then the process of amplification of the magnetic field by the differential rotation of the Sun begins 0.85 years before the beginning of the 11-year cycle. The paper also discusses the question of when the assumption that $\sec \psi = \tan \psi$, used in the mathematical formulation of Babcock's theory, is valid. (auth)

46230 TABLES FOR COMPUTING DIELECTRONIC RECOMBINATION RATES FROM BURGESS' GENERAL FORMULA. Letfus, V. (Astronomical Inst., Ondrejov, Czech.). Bull. Astron. Inst. Czech., 20: 159-63(1969).

The general formula for computing dielectronic recombination, as derived by Burgess (1965), is arranged for use in tabular form. Given are some conditions relevant for the computation in practice. (auth)

Galaxies

Refer also to abstracts 46166 and 46297.

46231 INTERSTELLAR DUST. Witt, Adolf N. pp 291-303 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

Photoelectric measurements using three different filters are used to determine the intensity and distribution of the diffuse galactic radiation that originates in the interaction of starlight with interstellar dust. The results are compared with radiative transfer calculations using the albedo γ and scattering asymmetry factor g for four different models of interstellar particles. The Platt model gives the best fit. (auth)

46232 A NOTE ON THE SYSTEMIC VELOCITY OF M 31. Rubin, V. C.; D'Odorico, S. (Carnegie Institution of Washington, D. C.). Astron. Astrophys., 2: 484-8(Aug. 1969).

Earlier determinations of the central velocity of M 31 are presented and briefly discussed. These values come either from observations of the central region, or from the assumption of symmetry of the rotation curve. The weighted mean velocity is $V_c = -300 \pm 4$ km/s for the optical values. Recent interferogram observations of the northeast arm of M 31 by Deharveng and Pellett are reanalyzed in order to determine the central velocity under the assumption that V_{rot} is constant rather than V_{rot}/R. The dependence of the central velocity on these two different hypothesis and on the adopted inclination of the galaxy is examined. For the generally adopted value of the inclination $\xi = 77°$ velocity $V_c = -295 \pm 4$ km/s is obtained. (auth)

46233 MAGNETIC FIELDS AND HIGHLY CONDENSED OBJECTS. Hoyle, F. (Cambridge Univ., Eng.). Nature (London), 223: 936(Aug. 30, 1969).

It is accepted that highly condensed objects are important energy sources in the Universe, and the question arises as to whether they augment the galactic field by dynamo action. This could happen through the winding by rotation of a field that emerges from the object. This question is discussed both for our own Galaxy and the very different case of the Crab Nebula. It appears possible that the magnetic field of the Crab Nebula might have been produced by the central object, if the original rotary energy was large enough. While the process does not explain the origin of an initial field, it permits amplification of such a field, and it also gives satisfactory results for our Galaxy. Field amplification in the Galaxy appears to be essentially complete. It is noted that many small masses are less efficient than one object of the same

total mass, unless the fields produced by the small masses have the same sense. (UK)

46234 SOLAR MOTION WITH RESPECT TO THE HIGH-VELOCITY H I CLOUDS AND TO THE LOCAL GROUP. de Vaucouleurs, G.; Peters, W. L. (Univ. of Texas, Austin). Nature (London), 223: 938(Aug. 30, 1969).

It was suggested by Kerr (Astron. J., 73: S102(1968)) that the high velocity HI clouds may be satellites of the Galaxy, and by Verschuur (Astrophys. J., 156: 771(1969)) that they may possibly be extragalactic and purely gaseous members of the local group. The present authors re-examined the problem in terms of the solar apex and velocity which, by comparison with corresponding values for the local group, may give some indication of the relationships between the Galaxy, the local group, and the system of low velocity HI clouds. The authors state that, on present evidence, the extragalactic hypothesis does not seem probable. (UK)

46235 AGE AND INITIAL HELIUM ABUNDANCE OF GLOBULAR CLUSTER STARS. Iben, I.; Rood, R. T. (Massachusetts Inst. of Tech., Cambridge). Nature (London), 223: 933-4(Aug. 30, 1969).

It has been shown that the number of horizontal branch stars (N_{HB}) relative to the number of red giant stars (N_{RG}) brighter than an appropriate magnitude could be used, together with other observable cluster characteristics, to estimate the age and initial He abundance of stars in globular clusters. With the metal abundance parameter chosen as about 2×10^{-4}, the initial He abundance of stars in the cluster M15 has been estimated as about 0.25 to 0.27 and the cluster age as about (8 to 10.5) $\times 10^9$ yr. The only uncertainty considered in these estimates was N_{HB}/N_{RG}, and the estimates were on the basis of stellar models constructed with early approximations to the radiative and conductive opacities. In the present communication the analysis is repeated on the basis of (a) main sequence and horizontal branch models constructed with new radiative opacities calculated by Cox and Stewart (to be published in Astrophys. J.) and (b) models at the red giant tip constructed by Eggleton (to be published in Mon. Not. Roy. Astro. Soc.) using radiative opacities that agree well with those of Cox and Stewart. The results are to be regarded primarily as an additional step toward an eventual solution of the age and He abundance problem, in so far as such a solution relies on comparisons between observations and theoretical models of the stellar interior. (UK)

Cosmology

Refer also to abstracts 46294, 46803, 46819, and 46822.

46236 SYMMETRY AND COSMOLOGY. Treder, H.-J. Monatsber. Deut. Akad. Wiss. Berlin, 11: 226-30(1969). (In German).

It is shown theoretically that hypotheses expressed by Heisenberg on the relation between electromagnetism and the cosmos are very problematical. The isospin and asymmetry of the baryon number in the universe are calculated. Invariance was calculated in contrast with the charge conjugations and the existence of antimatter in the universe. (J.S.R.)

46237 GRAVITATIONAL INSTABILITY IN THE LEMAITRE UNIVERSE. Nariai, Hidekazu (Hiroshima Univ.). Progr. Theor. Phys. (Kyoto), 41: 1379-81(May 1969).

It has recently been asserted by several authors that the presence of the standard redshift $z_{abs} \sim 1.95$ for quasars with $z_{em} > 1.95$ may support an expanding model universe with positive curvature such as $\Lambda = \Lambda_c (1 + \Delta)$ rather than those with $\Lambda = 0$, where Λ_c is the value for the Einstein universe and $0 < \Delta \ll 1$. Since the standard redshift would have occurred at a stage of the Lemaître universe that had a minimum expansion velocity, the stage would also be appropriate for the growth of a density perturbation. Taking this situation into account, the gravitational instability in an expanding universe is discussed. (W.D.M.)

46238 PRIMORDIAL HELIUM PRODUCTION IN "MAGNETIC" COSMOLOGIES. Greenstein, G. (Yeshiva Univ., N. Y.). Nature (London), 223: 938-9(Aug. 30, 1969).

It has been shown that in the presence of a very intense magnetic field ($B \gtrsim 10^{13}$G) the neutron should decay more rapidly than in the field-free case. If such fields had existed during the very early stages of a "big-bang" cosmology they would have altered the expected primordial He abundance, and decrease in the neutron half-life would have tended to reduce this abundance. An analysis is given of the effects such a field would have produced, and it is concluded that for $10^{12}\text{G} \lesssim B \lesssim 10^{17}$G at the epoch of nucleosynthesis either too much ^{4}He or too much D and ^{3}He would have been produced. This is considered to be good evidence that such fields could not have existed during the "big-band." (UK)

46239 GRAVITATIONAL STABILITY OF CYLINDERS IN AN ALIGNED MAGNETIC FIELD. Wentzell, R. A. (Univ. of Waterloo, Ont.). Can. J. Phys., 47: 1349-53(July 1, 1969).

An examination was made of the gravitational instability of an infinite, perfectly conducting cylinder, maintained by its intrinsic gravitational force, with an axial magnetic field, and surrounded by fluid of a different density. The magnetic field will suppress any axisymmetric instability due to axial flow if the Alfvén velocity is greater than the streaming velocity. (auth)

46240 EFFECT OF VARIOUS CROSS-SECTION ENERGY DEPENDENCES IN CALCULATIONS OF COSMOLOGICAL VISCOSITY. Matzner, Richard A. (Univ. of Texas, Austin). Astrophys. Space Sci., 4: 459-63(Aug. 1969).

The Einstein field equations for homogeneous cosmologies are considered within the viscosity approximation. It is shown that some power laws $\sigma \sim T^m$ (where T is the temperature) for the cross section σ lead to collisionless behavior near the initial singularity in a "big-bang" model. Under some circumstances one may have two viscous phases, as the cosmic fluid passes from collisionless to collisional to collisionless again, while the Universe expands. (auth)

Planetary Phenomena

46241 CHEMICAL ANALYSIS OF THE LUNAR SURFACE. Patterson, James H. pp 137-61 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

Exploiting the backscattering of alpha particles and proton production by alphas, three devices have been placed upon the lunar surface successfully by Surveyors V, VI, and VII. The results of each exploration are not inconsistent and suggest a basaltic type of material. Details of the experiments are presented and the interpretation of the data is discussed. (auth)

46242 LUMINESCENCE AND CHEMICAL EFFECTS OF SOLAR PROTONS INCIDENT UPON THE LUNAR SURFACE. Zeller, Edward. pp 162-76 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

Materials similar to those present on the lunar surface have been bombarded by protons under conditions analogous to those found on the Moon. Sputtering and hydration account for the observed production of OH, and probable formation of CH and SIH. As a control OD was also produced. During the time scale for proton interactions with lunar material, production of water and organic compounds is likely. Both the luminescence and the optical characteristics of the Moon can be profoundly affected by proton-induced chemical changes within the upper few microns of the lunar surface. (auth)

Atomic and Molecular Physics

46243 THE SLOWING DOWN OF ATOMS WITH E < 15 eV IN SOLIDS. Langhoff, H.; Weiss, J.; Schumacher, M. (Univ., Goettingen, Ger.). Z. Phys., 226: 49-59(1969).

The energy distribution of γ quanta emitted after a radioactive β decay contains information on the slowing down of the nuclear recoil from the preceding decay. Energy distribution of γ quanta observed with the nuclear resonance fluorescence method for ^{187}Re, ^{152}Sm, and ^{148}Sm are reanalyzed. It is shown that the Debye model applied for the description of the slowing down can account for the observed energy distributions. (auth)

Atomic, Electron, Ion, and Molecular Beams and Their Reactions

Refer also to abstract 46644.

46244 ION-IMPACT EXCITATION OF PURE VIBRATIONAL TRANSITIONS IN DIATOMIC MOLECULES. Moore, John H. Jr.; Doering, John P. (Johns Hopkins Univ., Baltimore). Phys. Rev. Lett., 23: 564-7(Sept. 15, 1969).

An ion-impact spectrometer has been constructed to measure the energy loss of ions inelastically scattered without charge exchange from molecular targets. Pure vibrational transitions excited by H^+ and H_2^+ projectiles of energies from 100 to 600 eV have been observed in H_2, D_2, and N_2. The angular distribution of scattered ions and the energy dependence for these processes have been investigated. The excitation cross sections for pure vibrational transitions are unusually large. (auth)

46245 A STUDY OF THE ENERGY SPECTRUM OF SECONDARY ELECTRONS PRODUCED BY α PARTICLES AND FISSION FRAGMENTS PASSING THROUGH THIN FILMS. Agranovich, V. M.; Daukeev, D. K.; Konobeev, Yu. V.; Lebedev, S. Ya. Zh. Eksp. Teor. Fiz., 57: 401-10(Aug. 1969). (In Russian).

Results of a study of the energy spectrum of secondary electrons produced by α particles or fission fragments traversing a thin aluminum film are presented. The electron spectrum was measured by the time-of-flight technique in which the time of initiation of emission was recorded by the momentum from the primary particles (fission fragment or α particle). Descriptions of the spectrometer and method of measurement are described. The results are described on basis of the thermal spike theory. (auth)

46246 CHARGE EXCHANGE OF ALKALI METAL IONS IN ALKALI METAL VAPOR AND INERT GASES. Pivovar, L. I.; Nikolaichuk, L. I.; Grigor'ev, A. N. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 57: 432-8(Aug. 1969). (In Russian).

The cross sections for resonance and nonresonance charge exchange of Li^+, Na^+ and K^+ ions in K and Na vapor and in the gases He, Ne, or Ar are measured at energies between 20 and 155 keV. The results for resonance charge exchange are "joined" with the results obtained at lower energies and are found to agree with the theoretical calculations. In the cases of nonresonance charge exchange for most of the pairs investigated the cross section is found to pass through a maximum. For both small and large values of ΔE the positions of the maxima are in accord with the theoretical calculations. (auth)

Atomic and Molecular Properties

Refer also to abstracts 46753, 46761, and 46803.

46247 (CONF-681060-(Absts.)) PROGRAM AND ABSTRACTS. TWENTY-FIRST ANNUAL GASEOUS ELECTRONICS CONFERENCE, OCTOBER 16-18, 1968. (Joint Inst. for Lab. Astrophysics, Boulder, Colo.). 86p.

46248 (UJV-2184-F) A COMPUTER (GIER-ALGOL) PROGRAM FOR COMPUTING ELECTRON AND POSITRON WAVE FUNCTIONS. Vinduska, M. (Ceskoslovenska Akademie Ved, Rez. Ustav Jaderneho Vyzkumu). July 1969. 30p. Dep. CFSTI (U. S. Sales Only).

The Algol program for computing electron and positron wave functions with phases is presented. The comparison with previous results is given. (auth)

46249 EXPERIMENTAL STUDIES ON THE METASTABLE LIFETIMES IN HELIUM AND NEON. Steinberg, Murray. Berkeley, Calif., Univ. of California, 1968. 97p.

Thesis.

A time-of-flight method for measuring the mean life of long-lived atomic states is described. Application of the method to the $(1s2s)\ ^1S_0$ state in helium results in a measurement of a pressure-limited lifetime that leads to the conclusion that the lifetime must be greater than 9 msec. A tentative conclusion resulting from an application of the method to neon is that the $1s^2\ 2s^2\ 2p^5\ (^2P^0)3s$ $J = 2$ state has a lifetime greater than 5 msec; while the $1s^2\ 2s^2\ 2p^5\ (^2P^0_{\frac{1}{2}})3s$ $J = 0$ state has a lifetime greater than 33 msec. (Diss. Abstr.)

46250 STATISTICAL ELECTRON-DENSITY DISTRIBUTIONS AND THOMAS-FERMI-DIRAC SCREENING FUNCTIONS FOR POSITIVE IONS WITH DEGREE OF IONIZATION ONE THROUGH FOUR. Abrahamson, Adolf A. (City Univ. of New York, N. Y.). Phys. Rev., 185: 44-56(Sept. 5, 1969).

Statistical electron-density distributions and Thomas–Fermi–Dirac (TFD) screening functions have been obtained for a total of 394 positive ions of elements having integral atomic numbers up to $Z = 105$, for 117 values of radial distance from the ionic center in each case. For degrees of ionization 1 through 4, the starting values of Z are 5, 6, 9, and 10, respectively. These solutions were calculated, in part, by using Thomas' solutions of the TFD equation in terms of the statistical electron distributions for nonintegral values of Z and Jensen's boundary conditions. Values for singly ionized cesium and francium, doubly ionized barium and cadmium, triply ionized lanthanum and actinium, and quadruply ionized cerium and thorium are given here. The complete set of tables for all 394 ions has been deposited with ASIS National Auxiliary Publications Service. (auth)

46251 ACCURATE ANALYTICAL SELF-CONSISTENT-FIELD WAVE FUNCTIONS FOR Pr^{3+}. Synek, M.; Timmons, W. (Texas Christian Univ., Fort Worth). Phys. Rev., 185: 38-41(Sept. 5, 1969).

Ab initio calculations by the analytical-expansion self-consistent-field method were carried out for the ground state of the laser-active ion Pr^{3+} ($Z = 59$), $4f^2\ ^3H$. The results represent the most accurate wave functions for Pr^{3+} available at this time. The knowledge of these wave functions is shifting the frontier of accurate analytical calculations into the group of rare earths. The numbers of basis functions in the analytical expansions were 10, 8, 5, and 6 for the symmetries s, p, d, and f, respectively. All the basis-function exponents were subjected to careful and exhaustive optimizations. (auth)

46252 ELECTRON AFFINITIES OF THE HEAVY ELEMENTS. Zollweg, R. J. (Westinghouse Research Labs., Pittsburgh). J. Chem. Phys., 50: 4251-61(May 15, 1969).

Horizontal analysis has been employed to obtain quantitative estimates for the electron affinities of the elements of the three long periods of the Mendeleev periodic table. Values for the A subgroup were normalized to published experimental values for bromine and iodine and an estimate for astatine, while those for the B subgroup were based on experimental values for the alkali and noble metals. The results are consistent with most of the published experimental values and with those negative ions detected. The near agreement between the electron affinities of the alkali metals and those of the excited rare gases with similar outer-shell configurations suggests that most of the polarization contribution arises from the outer shell. (auth)

46253 PERTURBATION STUDY OF SOME EXCITED STATES OF TWO-ELECTRON ATOMS. Sanders, Frank C.; Scherr, Charles W. (Univ. of Texas, Austin). Phys. Rev., 181: 84-97(May 5, 1969).

A perturbation study of the NP states of two-electron atoms was made. In particular, oscillator-strength values for the $(1^1S, 2^1P)$ and $(2^3S, 2^3P)$ transitions were obtained. The 2^1P and 2^3P states were studied through ninth and tenth order, respectively. In addition, the N^1P and N^3P states were studied in first order through the 10P member of the series. Perturbation energy coefficients and other expectation values for several important operators were computed. Perturbation energy coefficients for the 1^1S state (through 25th order) and 2^3S state (through 17th order) are also reported. Where comparison is possible, these results are in satisfactory agreement with the results obtained from variational calculations by C. L. Pekeris and co-workers. The variational perturbation method for excited states requires auxiliary conditions on the perturbation wave functions. The condition on the nth-order wave function is derived here. This is a generalization of the first-order condition given by Sinanoğlu. (auth)

46254 NEW FORMULAS FOR LOWER BOUNDS TO EXPECTATION VALUES. Weinhold, Frank (Univ. of California, Berkeley). Phys. Rev., 183: 142-7(July 5, 1969).

Two new formulas are presented for rigorous lower bounds to the true quantum-mechanical expectation value of an arbitrary positive Hermitian operator. These formulas strengthen and extend previous results while requiring relatively simple additional matrix elements. Illustrative numerical applications are made at two levels of approximation to various one- and two-electron properties, powers of r_1 and r_{12}, in the normal helium atom. (auth)

Positronium, Muonium, and Mesic Atoms and Molecules

Refer also to abstracts 46643 and 47045.

46255 (RCN-108) POSITRON ANNIHILATION IN METALS: A CONTRIBUTION TO THE ANALYSIS OF ANGULAR CORRELATION MEASUREMENTS, WITH AN APPLICATION TO COPPER. Mijnarends, P. E. (Reactor Centrum Nederland, Petten). Aug. 1969. 105p. Dep. CFSTI (U. S. Sales Only).

A new method of analysis is presented for reconstructing the momentum distribution of the radiation emitted by positrons annihilating in crystalline solids. This technique makes it possible to obtain information concerning the momentum distribution of the electrons. A theoretical treatment of the method is followed by a discussion of the effects of various geometrical corrections.

New angular correlation measurements on copper are reported. Application of the method to these measurements yields a Fermi surface in good quantitative agreement with results obtained by other methods in the [100] directions, while there is a 5% difference in the [110] directions. Possible reasons for the observed discrepancy are discussed. (auth)

46256 THEORETICAL AND EXPERIMENTAL POSITRON ANNIHILATION AND SCATTERING CROSS SECTIONS IN HELIUM. Tao, S. J.; Kelly, T. M. (New England Inst., Ridgefield, Conn.). Phys. Rev., 185: 135-40(Sept. 5, 1969).

A comparison is made between the experimental results and results calculated from theoretical values of annihilation and scattering (momentum-transfer) cross sections on free-positron-annihilation lifetime spectra in helium gas at temperatures of 4.2, 77, and 300°K. It is found that the annihilation cross section calculated by Drachman using Dalgarno and Lynn's complete first-order adiabatic correlation function, incorporated with the method of variational bounds, agrees with the experimental results. It is also found that both the momentum-transfer cross section calculated by Drachman with $\alpha = 0$ and $C = 1$ and the one by Massey et al. fit the experimental results well, although the one by Drachman seems to be better. The limitations of this method and the results using other values of cross sections are also discussed. (auth)

46257 POSITRON PRODUCTION DURING MUTUAL APPROACH OF HEAVY NUCLEI AND VACUUM POLARIZATION. Gershtein, S. S.; Zel'dovich, Ya. B. (Inst. of Applied Mathematics, Moscow). Zh. Eksp. Teor. Fiz., 57: 654-9(Aug. 1969). (In Russian).

Spontaneous formation of electron–positron pairs due to gradual transition of the potential through the critical value corresponding to removal of the energy barrier for such pair production is considered. A possible example is the assumed production of pairs which occurs when bare subcritical nuclei approach each other. It is suggested that the distribution of the charge densities of an electron bound to a level $\epsilon_1 = -mc^2$ together with the density distribution of a polarized charge should be localized near the nucleus (whereas the charge density of only the bound electron should be delocalized). It is pointed out that polarization of vacuum for heavy nuclei should differ from that for light nuclei. This difference corresponds to adiabatic escape to infinity of positrons when the critical nuclear charge is attained. (auth)

Collision Phenomena

46258 CALCULATION OF THE MOMENTUM-TRANSFER CROSS SECTION OF ELECTRONS IN CESIUM VAPOUR FROM DRIFT-VELOCITY MEASUREMENTS. Postma, A. J. (EURATOM–FOM, Jutphaas, Netherlands). Physica, 43: 465-74 (July 29, 1969).

The electron energy distribution function was solved numerically from the Boltzmann equation in the Lorentz approximation. Elastic and inelastic electron–atom collisions were taken into account. From the energy distributions the drift velocities of the electrons were calculated. By comparing these velocities with the measured ones by means of a trial and error method, values of the momentum-transfer cross section for electron–atom collisions were obtained. (auth)

46259 ON THE IMPACT OF PROTONS ON HYDROGEN ATOMS. I. INTRODUCTION. THE PARAMETRIC TREATMENT AND THE DERIVATION OF SOME OF ITS PROPERTIES. Fennema, J. W. R. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 43: 375-400(July 29, 1969).

The theory of proton–hydrogen collisions in the energy range 0.5 to 50 keV is considered. In order to provide a basis for later discussions and for the stating of specific problems the body of the existing conventional approach, the so-called parametric or impact-parameter method, is assembled and adapted to the investigation. (auth)

46260 ON THE IMPACT OF PROTONS ON HYDROGEN ATOMS. II. FUNDAMENTAL ASPECTS CONCERNING THE PARAMETRIC TREATMENT. Fennema, J. W. R. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Physica, 43: 401-18(July 29, 1969).

The parametric (or impact parameter) method, which is often used to describe atomic collision processes, is considered on the basis of the corresponding quantum mechanical treatment. A method for constructing asymptotically stationary functions needed for the description of the electron cloud(s) is presented. Next, the pertinent quantum mechanical theory is developed and the size of possible wave packets is estimated. It appears that, with respect to the microscopic phenomena, the parametric picture should be derived from impinging monochromatic beams of particles. After that the concept of delay-time is considered. Finally the parametric equations for the probability amplitudes are derived; in this respect it is also demonstrated that the internuclear potential energy and the phase of the initial boundary condition have no observable meaning. (auth)

46261 TOTAL CROSS SECTIONS FOR CHARGE TRANSFER BETWEEN ALKALI ATOMS AND HALOGEN MOLECULES. Baede, A. P. M.; Moutinho, A. M. C.; de Vries, A. E.; Los, J. (FOM-Instituut voor Atoom- en Molecuulfysica, Amsterdam). Chem. Phys. Lett., 3: 530-1(July 1969).

Ionic products were observed in collisions of alkali metal atoms and halogen molecules in the eV region. The energy dependence of the total cross sections for ion production was measured for K, Na, and Li on Br_2 and a discussion of the results is given based on the Landau–Zener formula. (auth)

46262 BORN WAVE CALCULATION OF ATOM–ATOM INELASTIC CROSS SECTIONS: DESCRIPTION OF TARGET ATOMS BY ELASTIC AND INELASTIC X-RAY FORM FACTORS. Levy II, H. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Phys. Rev., 185: 7-15(Sept. 5, 1969).

Total electron-loss cross sections for H atoms in collision with He, Ne, Ar, Kr, C, N, and O over the range of incident energy 1 keV to 100 MeV and total (1s–2l) excitation cross sections for H atoms in collision with He, Ne, Ar, and Kr over the range of incident energy 0.1 keV to 10 MeV are calculated by using the first Born wave approximation and assuming closure. The relevant matrix elements for the target atoms are expressed in terms of elastic and inelastic x-ray form factors. The calculations agree, within experimental error, with high-energy measurements for He, N, and O targets. Good agreement between theoretical and experimental excitation cross sections is found at energies as low as 5 keV for He, Ne, and Kr targets when the Ne and Kr calculations are scaled with a velocity-dependent parameter calculated by matching theoretical and experimental ionization data. An explanation for the velocity-dependent scaling of the theoretical cross sections for many electron target atoms at energies up to 1 MeV is presented and discussed. (auth)

46263 MULTIPHOTON IONIZATION OF ATOMIC HYDROGEN. Chan, F. T.; Tang, C. L. (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 185: 42-4(Sept. 5, 1969).

To resolve the discrepancy between the numerical results of Zernik and those of Gontier and Trahin for two-photon ionization of atomic hydrogen in the ground state, a third method was used to obtain the numerical results. The results agree exactly with those of Zernik. (auth)

46264 HIGH-ENERGY BREMSSTRAHLUNG IN COLLISIONS OF ELECTRONS WITH ONE- AND TWO-ELECTRON ATOMS. Gould, Robert J. (Univ. of Sydney. Univ. of California, San Diego). Phys. Rev., 185: 72-9(Sept. 5, 1969).

A brief discussion of the fundamental formulas for electron–electron and electron–atom bremsstrahlung is given. Some general results are given for complex atoms and explicit expressions for the cross sections for one- and two-electron atoms are exhibited graphically. It is shown that for 1e and 2e atoms that have a residual charge, that is, for ions, the total cross section is composed of several terms, one of which is $(Z-1)^2$ or $(Z-2)^2$ (respectively) times the cross section for electrons incident on unshielded protons. Some results for general atoms or molecules in the high- and low-energy limits are indicated. (auth)

46265 LINE-BROADENING THEORY FOR POSITIVE IONS. Bely, O. (Observatoire, Nice). Phys. Rev., 185: 79-82(Sept. 5, 1969).

It is shown that the impact-approximation linewidth of positive-ion lines is generally a continuous function of the energy of the perturbing electrons, when the width is averaged over resonances. Special cases are also discussed. (auth)

46266 MEASUREMENT OF THE TOTAL CROSS SECTION FOR CHARGE TRANSFER INTO THE METASTABLE STATE H(2s) FOR PROTON COLLISIONS WITH ATOMIC HYDROGEN. Bayfield, James E. (Yale Univ., New Haven). Phys. Rev., 185: 105-12(Sept. 5, 1969).

The total cross section $\sigma_{2s}(H)$ for $H^+ + H(1s) \rightarrow H(2s) + H^+$ has been measured over the energy range 3 to 70 keV. Above 10 keV, absolute cross-section values are believed accurate to within ±35%. Only one maximum is found in the energy dependence of $\sigma_{2s}(H)$. The position of this maximum lies at an energy consistent with the Massey criterion. A comparison with theoretical cross sections suggests that intermediate-state coupling through the

resonant charge-transfer channel $H^+ + H(1s) \rightarrow H(1s) + H^+$ is unimportant at low energies. The low-energy data are consistent with a molecular picture of the collision. Calculations utilizing Sturmian wave functions are not in agreement with the data. The Born approximation cross section lies significantly below experiment between 20 and 70 keV. (auth)

46267 TABLES OF COEFFICIENTS TO DETERMINE THE LONG-RANGE CONTRIBUTIONS TO LOW-ENERGY ELECTRON–ATOM SCATTERING. Berger, R. Oppenheim; Snodgrass, H. B.; Spruch, Larry (New York Univ., N. Y.). Phys. Rev., 185: 113-28(Sept. 5, 1969).

The difficulty in the extrapolation or interpolation in energy of the phase shifts deduced from electron-atom scattering data stems from the presence of an effective one-body long-range potential U(r). U(r) has its origin in the static and dynamic polarizabilities of the atom, assumed to have a spherically symmetric ground state, and gives rise to an unusual and rapidly varying energy dependence. The usual effective-range theory is inapplicable, but a modified effective-range theory (MERT) exists in which the effect of U(r) is taken into account exactly for arbitrarily strong (but specified) U(r). The applicability of MERT has previously been limited to U(r) sufficiently weak for the Born approximation to be adequate (because of the unavailability of numerical values for the long-range functions necessary for the analysis). Here these functions for the case in which $U(r) \rightarrow -\frac{1}{2}\alpha_1 e^2/r^4$, where α_1 is the atomic electric dipole polarizability, are tabulated. The functions have been tabulated in terms of dimensionless parameters over a range of values of angular momentum L, α_1, and wave number k such that the entire elastic region for almost all atoms can be covered. The only interpolation necessary is that over k. A study of the e^-H and e^+H L = 0 phase shifts provides an illustration of the application of the tables. (auth)

46268 EQUILIBRIUM CHARGE-STATE DISTRIBUTIONS FOR IODINE IN GASES (1 TO 12 MeV). Ryding, G.; Wittkower, A. B.; Rose, P. H. (High Voltage Engineering Corp., Burlington, Mass.). Phys. Rev., 185: 129-34(Sept. 5, 1969).

Equilibrium charge-state fractions F_i have been measured for iodine beams with energies between 1 and 12 MeV traversing gas targets of H_2, He, O_2, Ar, and Kr. Charge states from 0 to 14 were detected. At each energy, considerable differences in the charge-state distributions were observed in the different gases; both the mean charge $\bar{I}$ and the distribution width σ showed strong dependence on the target gas. At energies above 3 MeV the value of $\bar{I}$ was greatest in O_2 and least in H_2, and at all energies the value of σ was greatest in O_2 and least in H_2. At 12 MeV, values of $\bar{I}$ and σ in O_2 were 6.15 and 2.04, respectively, whereas in H_2 the corresponding values were 4.02 and 1.12. (auth)

46269 HEAVY-PARTICLE ENERGY-LOSS SPECTROMETRY: INELASTIC CROSS SECTIONS FOR PROTONS INCIDENT UPON HELIUM. Park, John T.; Schowengerdt, F. D. (Univ. of Missouri, Rolla). Phys. Rev., 185: 152-64(Sept. 5, 1969).

A method is described whereby absolute cross sections are obtained from inelastic energy-loss spectra induced by ions incident upon gaseous targets at energies of 25 to 125 keV. Inelastic energy-loss spectra of helium for proton impact are presented. Apparent differential cross sections and absolute total cross sections are obtained from the spectra. Total cross sections for the sum of the $1^1S \rightarrow 2^1S$ and $1^1S \rightarrow 2^1P$ excitations are reported, along with estimates of the relative contributions of each. Total ionization cross sections, total cross sections for inelastic scattering, apparent energy distributions of ejected electrons, and partial ionic stopping powers are also reported. The excitation cross sections show excellent agreement with recent calculations on the coupled-state approximation. The ionization cross sections show good agreement with results obtained by other methods, except at the lower impact energies. The apparent energy distributions of ejected electrons fall below the results of direct measurements and show poor agreement with the available theory. (auth)

46270 X-RAY PRODUCTION IN C^+–C COLLISIONS IN THE ENERGY RANGE 20 keV TO 1.5 MeV. Fortner, R. J.; Curry, B. P.; Der, R. C.; Kavanagh, T. M.; Khan, J. M. (Univ. of California, Livermore). Phys. Rev., 185: 164-7(Sept. 5, 1969).

Cross sections for carbon K-x-ray production for C^+ ions incident upon a carbon target have been measured in the energy range 20 keV to 1.5 MeV. A theoretical model based on the Landau–Zener theory of level crossing is formulated and is found to fit the experimental data within experimental uncertainty. (auth)

46271 TWO-STATE THEORY OF DISSOCIATIVE ATTACHMENT. Mittleman, Marvin H. (City Univ. of New York, N. Y.). Phys. Rev., 185: 394-6(Sept. 5, 1969).

Chen and Mittleman have recently cast doubt upon the two-state theories of dissociative attachment and gave a more cumbersome three-state theory. A new definition of the resonance state is given here, which does not suffer from the previous difficulties. This is accomplished at the expense of giving up the Born–Oppenheimer approximation in a region in which it is shown to be invalid anyway. The result is a theory almost identical to previous two-state theories, with the new definition of the diabatic state replacing the old one. (auth)

46272 SPIN-EXCHANGE IN COLLISIONS BETWEEN ATOMS. Burnham, David C. (Electronics Research Center, Cambridge, Mass.). Phys. Rev., 185: 399-401(Sept. 5, 1969).

The work of Glassgold on spin exchange in collisions between atoms is extended to include target polarization. The appropriate averages are taken for spin-exchange collisions that occur in low magnetic fields, but for which the incident and scattered beams are selected in a high magnetic field. (auth)

46273 DETACHMENT FROM THE NEGATIVE HYDROGEN ION BY ELECTRON IMPACT. Tietz, T. (Univ. of Lodz, Poland). Nuovo Cim., 62B: 309-16(Aug. 11, 1969).

The problem of detachment from the negative hydrogen ion by electron impact is discussed. All calculations involving the negative hydrogen ion are based on the choice of a single-electron bound-state wave function connected with the Hartree effective central potential. There is given a simple wave function, which may be helpful in all calculations connected with the negative hydrogen ion problem. (auth)

46274 POSITRONIUM FORMATION BY THE PASSAGE OF POSITRONS THROUGH AN ELECTRON GAS. Pradhan, T.; Tripathy, D. N. (Saha Inst. of Nuclear Physics, Calcutta). Nuovo Cim., 62B: 317-33(Aug. 11, 1969).

A new approach to the problem of positronium formation in an electron gas is discussed by considering the competing processes of thermalization of the incident positron, capture of an electron by the positron, and disintegration of the positronium so formed. The methods of quantum field theory of the electron gas were used to calculate 1) the probability of finding the 1s and 2s states of positronium (plus a hole) in a positron beam passing through the electron gas, 2) the probability of disintegration of the positronium states into electrons and positrons as a result of many-body interactions, and 3) the cross section for thermalization of the incident positron. These calculations show that, although the positronium formation cross section is comparable to the rest of the competing processes for most incident-positron energies, there is, nevertheless, a very narrow band of energies where this cross section dominates the rest. Therefore, in spite of thermalization of the incident positron and disintegration of the positronium formed in the metal, a large fraction of the incident beam will be converted to positronium when equilibrium is reached during its passage through the electron gas. (auth)

46275 EMISSION CROSS SECTION MEASUREMENTS IN PROTON–NITROGEN COLLISIONS USING PHOTON COINCIDENCE TECHNIQUES. Young, Stephen James. College, Alaska, Univ. of Alaska, 1968. 94p.

Thesis.

The measurement of a cross section for the emission of a Balmer alpha (6563A) and an N_2^+ (0,0) first-negative-band (3914A) photon from a hydrogen atom and an N_2^+ molecule excited simultaneously in the same $H^+ + N_2$ charge-exchange collision is performed in the proton velocity range from 0.54×10^8 cm/sec (1.5 keV) to 2.40×10^8 cm/sec (30.2 keV). The measurement is accomplished using the technique of photon–photon coincidence detection. Details of the technique are presented. The simultaneous specification of the emissions (and hence final-state excitations) of both systems produced in the collision makes this the first measurement of an emission cross section for a well specified charge-exchange reaction. The specific cross section measured is that for the emissions resulting from simultaneous excitation of the $B^2\Sigma_u^+$, $v' = 0$ state of N_2^+ and the 3p or 3d state of hydrogen. To within the random error associated with the experiment, the cross section has only a single-peak structure with a maximum value of 1.2×10^{-18} cm^2 at a velocity of 1.15×10^8 cm/sec (6.9 keV). The primary significant result of the investigation is the exceptionally good agreement in both shape and magnitude between the measured cross section and the cross section, σ_{uc}, calculated on the assumption that the final-state excitations of the two product systems are independent events. The average value of the ratio of the measured cross section to σ_{uc} for the twelve measured values of the cross section is 1.11 ± 0.34. Secondary results are the remeasurement of the total cross section for the production of 3914A emission in $H^+ + N_2$ collisions showing good agreement with previous measurements and the redetermination of the total cross section for the production of Balmer alpha emis-

sion in the same type collisions showing varying degrees of agreement with previous measurements. (Diss. Abstr.)

46276 ELASTIC SCATTERING OF LOW-ENERGY ELECTRONS FROM METASTABLE HELIUM. Sklarew, Ralph C. Riverside, Calif., Univ. of California, 1968. 90p.

Thesis.

The cross sections for elastic scattering of low-energy electrons by metastable helium in the 2^3S state were calculated using approximations to the polarized orbital formalism. The spin-flip scattering cross sections at very low energies were also calculated. The perturbed orbitals for the 1s and 2s states of metastable helium are the solutions of the fully coupled, first-order perturbed Hartree–Fock equations. The perturbation was taken to be a point charge and an adiabatic approximation was employed. The effects on the cross sections of electron exchange, an adiabatic polarization potential, and a nonadiabatic distortion potential are examined for this scattering process. The overestimation of the attraction between the metastable helium atom and the scattering electron given by the adiabatic polarization approximation is demonstrated. A nonadiabatic distortion potential is employed to reduce the attraction, but this is seen to be an overcorrection and the resulting potential is too repulsive to bind the known helium ion in the ^4P_s state. (Diss.Abstr.)

46277 RESONANCE THEORY OF TERMOLECULAR RECOMBINATION KINETICS: H + H + M → H_2 + M. Roberts, Robert E.; Bernstein, R. B.; Curtiss, C. F. (Univ. of Wisconsin, Madison). J. Chem. Phys., 50: 5163-76(June 15, 1969).

A theory is formulated for atomic recombination reactions, which is based upon the identification of the set of transition complexes, $X_{ij}^{\ddagger}$, as specific quasi-bound states or orbiting resonances. The conventional "energy-transfer mechanism" is assumed, since it has been justified under many experimental situations. Calculations, based on a modified distorted-wave approximation, demonstrate that the main contribution to the rate is that arising from rotational (rather than vibrational) transitions downwards from the quasi-bound to the bound states. Computations were carried out for the reaction H + H + M → H_2 + M for M = He, H_2, and Ar making use of detailed ab initio knowledge of the spectrum of quasi-bound states and their wave functions. Good agreement was found between the experimental rate constant and that calculated by the present resonance theory. The theory predicts a maximum in the rate in the temperature range between 65° and 100°K, attributed mainly to one particular quasi-bound state: v = 14, j = 5. This suggests a promising region for further experimental investigation, which could provide a critical check of the present theory. (auth)

46278 MONTE CARLO TRAJECTORY CALCULATIONS OF ATOMIC EXCITATION AND IONIZATION BY THERMAL ELECTRONS. Mansbach, Peter; Keck, James (Avco Everett Research Lab., Everett, Mass.). Phys. Rev., 181: 275-89(May 5, 1969).

The excitation and de-excitation of atoms by electron impact has been investigated for states near the ionization limit using classical Monte Carlo trajectory calculations. The trajectories were sampled within the reaction zone with a weight proportional to the equilibrium reaction rate and integrated backward and forward in time to obtain complete histories for the collisions. This method is very much more efficient than the usual technique of sampling outside the reaction zone, and makes an otherwise extremely expensive calculation feasible. The results indicate that for energy transfers less than a few kT the reaction cross section is determined by adiabatic collisions, while for transfers greater than a few kT the impulse approximation is valid. The data have been used to obtain the following convenient approximation for the equilibrium transition kernel valid near the ionization limit: $R(E_i,E_f) = 7.8\times10^{-26}[A^+]_e[e]_e^2[kT(eV)]^{-11/2}(-E_<\!/kT)^{-4.5}\exp(-E_>\!/kT)$ cm^{-3} sec^{-1} eV^{-2}, where $E_< = \min(E_i,E_f)$, and $E_> = \max(E_i,E_f)$. This has been used in conjunction with a conventional master equation to obtain an exact expression for the steady state collisional recombination rate constant $a = 2.0\times10^{-27}[e][kT(eV)]^{-9/2}$ cm^3/sec. Comparison with the available experimental data is reasonably good, but there are indications that both radiative cascading and collisions with neutrals may be important under some experimental conditions. (auth)

46279 CHARGE EXCHANGE AND IONIZATION CROSS SECTIONS ON COLLISIONS OF PROTONS WITH ^{3}He AND ^{4}He. Becker, Mark; Scharmann, Arthur (Univ., Giessen, Ger.). Z. Naturforsch., 24a: 854-5(May 1969). (In German).

The charge-exchange and ionization cross sections were measured in the proton bombardment at 3 to 30 keV of ^{3}He and ^{4}He in order to detect a possible isotope effect in the charge-exchange cross section. The cross sections obtained are graphed as functions of the proton energy. A relative difference in the charge-exchange cross sections of ^{3}He and ^{4}He can not be found within the measurement accuracy of 2 to 3%. No isotope effect could be measured. (J.S.R.)

46280 ELECTRON IMPACT EXCITATION OF CN. Crawford, O. H.; Allison, A. C.; Dalgarno, A. (Harvard Coll. Observatory and Smithsonian Astrophysical Observatory, Cambridge, Mass.). Astron. Astrophys., 2: 451-2(Aug. 1969).

Close-coupling calculations are presented of the cross sections for the 0–0, 0–1, and 0–2 rotational transitions in CN induced by impact of low-energy electrons. (auth)

46281 PRODUCT ENERGY DISTRIBUTION FOR AN ENDOTHERMIC REACTION: A + B → AB^+ + e. Myers, G. H.; Young, H. W. (Univ. of Florida, Gainesville). J. Chem. Phys., 51: 1597-1602(Aug. 15, 1969).

The product energy distribution for the reaction A + B → AB^+ + e (where A and B are atoms) is considered on a theoretical basis. Because of the large mass ratio of the products, conservation of energy and momentum largely determine the product energy distribution without requiring a detailed knowledge of the mechanics of the collision complex. By assuming a hard-sphere line-of-center model, it is shown that AB^+ would be produced with thermal translational and rotational energies. The sum of the average AB^+ vibration and electron translation energies is kT. Detailed balancing is used to estimate the partitioning of this kT energy between the AB^+ vibration and electron kinetic degrees of freedom. Calculations are presented showing the dependence of electron energy on reaction temperature and the AB^+ vibrational frequency. The electron must always be produced at less than thermal energies. For the reaction N + O → NO^+ + e at 6500°K it is estimated the electron would be produced at 1800°K. (auth)

46282 MASS-SPECTROMETRIC STUDY OF THE BIMOLECULAR FORMATION OF DIATOMIC HELIUM ION. DeCorpo, J. J.; Lampe, F. W. (Pennsylvania State Univ., University Park). J. Chem. Phys., 51: 943-51(Aug. 1, 1969).

The homonuclear diatomic ion of He has been studied by a pulsed mass-spectrometric technique. These investigations of the bimolecular formation of He_2^+ show that at least four families of excited states take part in the process. Three of these states have excitation functions with peaks at 36, 58, and 68 eV, while the fourth peaks between 30 and 34 eV. Kinetic studies performed at these electron energies yielded the effective lifetimes, as well as specific reaction rates for the corresponding families of the excited states. The observed rate constants (1.8 to 3.6×10^{-9} cm^3 $molecule^{-1}\cdot sec^{-1}$) correspond to reaction diameters comparable to collision diameters expected on the basis of simple theoretical consideration of the radius of the excited helium atom. (auth)

46283 ELECTRON ATTACHMENT TO N_2O. Chaney, E. L.; Christophorou, L. G. (Oak Ridge National Lab., Tenn.). J. Chem. Phys., 51: 883-93(Aug. 1, 1969).

Electron attachment to N_2O has been studied with the swarm method in mixtures with argon and nitrogen, and the measured absolute attachment rates have been combined with beam data on the production of O^- from N_2O. The cross section for the production of O^- from N_2O at 373°K has a peak value of 8.3×10^{-18} cm^2 at 2.3 eV. In the energy region between ~0.2 and ~1.5 eV the cross section for the production of O^- from N_2O increases with increasing temperature ($323° \le T \le 473°K$), suggesting dissociative attachment from higher vibrational levels of N_2O. The results on mixtures with N_2 evidence the formation of N_2O^- as a primary product of electron attachment. The apparent three-body attachment rate coefficient increases with increasing electron energy, suggesting an activation energy for the formation of N_2O^-. The various swarm and beam data on electron attachment to N_2O are compared and discussed. This study demonstrates further the potential of the swarm–beam technique. (auth)

46284 DISPERSION CALCULATION OF RESONANT PHOTOIONIZATION LINE SHAPES: APPLICATION TO HELIUM. Reinhardt, William P. (Harvard Univ., Cambridge, Mass.). Phys. Rev., 182: 64-76(June 5, 1969).

For resonant photo-ionization of spherical atoms, unitarity and simple assumptions about the analytic properties of inelastic scattering amplitudes allow calculation of the photo-ionization line shape from the elastic final-state phase shift. Explicitly, the Fano shape factor, q, is given by $\cot\delta^{nr}$, where δ^{nr} is the non-resonant elastic phase shift for the final state. This result predicts that if δ^{nr} is constant for a series of resonances below an inelastic threshold, the values of q will be constant for the series and independent of the type of resonance. For photo-ionization of helium, values of q calculated from the elastic phase shifts are seen to be in fair agreement with those calculated from wave functions. (auth)

46285 ANGULAR DISTRIBUTION OF PROTONS FROM COLLISIONAL DISSOCIATION OF H_2^+. I. Green, Thomas A.; Peek, James M. (Sandia Lab., Albuquerque, N. Mex.). Phys. Rev., 183: 166-79(July 5, 1969).

The theory of the angular distribution of H_2^+ dissociation fragments resulting from H_2^+ collisions with neutral or charged targets is developed in the Born approximation. Earlier formulations of the problem are corrected and generalized. Calculations of the angular distributions for collisions that leave the H_2^+ in the $2p\sigma_u$, $2s\sigma_g$, and $2p\pi_u$ electronic states are carried out for He and Ar targets. It is assumed that the target either remains in its ground electronic state or undergoes an allowed transition. It is shown that the angular distributions vary considerably with the final H_2^+ electronic state considered, with the final kinetic energy of the H_2^+ fragments, with the final state of the target, and with the H_2^+ impact energy. Angular distributions for transitions to highly excited and ionized states of H_2^+ are considered in a qualitative way. (auth)

Atomic Theory

Refer also to abstract 47085.

46286 NATURAL ORBITALS, DIVERGENCES, AND VARIATIONAL PRINCIPLES. Kobe, Donald H. (North Texas State Univ., Denton). J. Chem. Phys., 50: 5183-94(June 15, 1969).

Bogolyubov's principle of compensation of dangerous diagrams (PCDD) is extended to finite fermion systems and is shown to give Löwdin's natural spin orbitals (NSO), which diagonalize the single-particle reduced density matrix. Hartree–Fock theory corresponds to the compensation of the lowest-order dangerous diagrams, which cause divergences in the perturbation expansion of the ground-state energy. The PCDD is then derived from a variational principle that the number of particle–hole excitations in the true ground state is a minimum. The sense in which the NSO give the most rapid rate of convergence of the configuration-interaction expansion of the true wave function is also discussed. (auth)

46287 GENERALIZATION OF THE KITTEL–VAN VLECK RELATION BETWEEN g AND g' FOR MORE THAN TWO LEVELS. Foglio, M. E. (Harvard Univ., Cambridge, Mass.). Phys. Rev. Lett., 23: 577-8(Sept. 15, 1969).

A generalization of the Kittel–Van Vleck relationship between the gyromagnetic factor g' and the spectroscopic splitting factor g is given for a large class of spin Hamiltonians with any number of levels. (auth)

46288 COMPTON SCATTERING OF PHOTONS BY BOUND K-SHELL ELECTRONS. Gavrila, M. (Univ. of Bucharest). Nuovo Cim., Lett., 2: 180-4(Aug. 11, 1969).

When the electron taking part in Compton scattering is considered to be initially in a bound atomic state, significant deviations may appear from the conventional case of a free initial state. The influence of binding was studied in several works, both from the nonrelativistic and relativistic points of view. All of them contain various approximations; those referring to the nonrelativistic case all neglect the contribution to the matrix element of the sum over intermediate states. The results of an exact analytic evaluation of the nonrelativistic cross section for Compton scattering by K-shell electrons, including retardation, are reported. (W.D.M.)

46289 THEORY OF ATOMIC STRUCTURE INCLUDING ELECTRON CORRELATION. I. THREE KINDS OF CORRELATION IN GROUND AND EXCITED CONFIGURATIONS. Oksuez, Iskender; Sinanoglu, Oktay (Yale Univ., New Haven. Middle East Tech. Univ., Ankara). Phys. Rev., 181: 42-53 (May 5, 1969).

There are novel correlation effects in excited states and configurations unlike those in closed shells. A theory for general nonclosed shells, and a method for calculation, are developed by separating the correlations into three mathematically and physically distinct types: (1) internal, (2) polarization plus semi-internal, and (3) all-external correlations. The first two of these are unique to open shells and strongly dependent on number of electrons, symmetry, and Z. They are however shown to be calculable by a finite configuration-interaction method, and their energy contributions and wave functions are computed using a fully automatic program for 113 states of $1s^2 2s^n 2p^m$ (n = 0,1,2; m = 0,1, . . . , 6) configurations for Z = 5 through 11. Both effects are found to be important in magnitude. The detailed wave functions obtained, which include those of positive and negative ions and of highly excited states containing inner 2s holes, are useful for obtaining atomic properties such as transition probabilities. The remaining all-external correlation energy is found to be, as predicted by the present theory, just like the correlation in closed shells, i.e., mainly made up of transferable pair correlations (evaluated in Paper II) and approximately transferable through Z in a given isoelectronic sequence. (auth)

46290 THEORY OF ATOMIC STRUCTURE INCLUDING ELECTRON CORRELATION. II. ALL-EXTERNAL PAIR CORRELATIONS IN THE VARIOUS STATES AND IONS OF B, C, N, O, F, Ne, AND Na, AND PREDICTION OF ELECTRON AFFINITIES AND ATOMIC EXCITATION ENERGIES. Oeksuez, Iskender; Sinanoglu, Oktay (Sterling Chemistry Lab., New Haven. Middle East Tech. Univ., Ankara). Phys. Rev., 181: 54-65(May 5, 1969).

The first paper of this series showed that the portion of the total correlation energy that remains after two types of correlation effects specific to N (number of electrons), symmetry state, and Z are taken out is quite similar in nature to correlation in closed shells. This remainder, the all-external energy, is expected to be largely made up of pair correlations whose values are transferable through N, symmetry state, and Z as predicted in the theory by Sinanoğlu. The present paper analyzes the all-external correlation energies of B, C, N, O, F, Ne, and Na into their irreducible all-external pair components. The predicted additivity and transferability of all-external pairs are found to hold within the error limits of experimental correlation energies. A set of such pair-correlation values applicable to a great many states and ions of $1s^n 2s^m 2p^k$ type are obtained. Together with the calculated values of the two other types of correlation effects, these yield nonrelativistic atomic energies to a root-mean-square deviation of 0.05 eV. A semiempirical method for the prediction of atomic energy levels of general nonclosed-shell species, excited configurations and states as well as ground states, is presented. The method is applied to predictions of electron affinities, excited states of negative ions, excitation energies, intermultiplet separations, and term-splitting ratios. Results of the method are compared with experiment and other semiempirical and nonempirical methods. (auth)

46291 CORRELATION ENERGIES OF SOME STATES OF 3- TO 10-ELECTRON ATOMS. Knight, Robert E. (Univ. of Kentucky, Lexington). Phys. Rev., 183: 45-51(July 5, 1969).

The nonrelativistic eigenvalues of several states of 3- to 10-electron atoms are calculated to second order in the nuclear charge Z. It is noted that with some modifications the Hylleraas variational procedure can be employed successfully for a many-electron atom. (auth)

46292 HIGH-ORDER PERTURBATION THEORY FOR THE BOUND STATES OF AN ELECTRON IN A SCREENED COULOMB POTENTIAL. Iafrate, Gerald J. (Inst. for Exploratory Research, Fort Monmouth, N. J.); Mendelsohn, Lawrence B. Phys. Rev., 182: 244-58(June 5, 1969).

The solution to the nonrelativistic Schrödinger equation for a bound electron in an attractive screened Coulomb potential is investigated using the large-Z (Z is nuclear charge) asymptotic expansion theory. Both the basic asymptotic and perturbation solutions are found. The problem of finding the kth-order perturbation wave function and energy for any state is reduced to solving, recursively, a set of k linear algebraic equations in k unknowns. The asymptotic expansions for the energy and wave functions are presented to the tenth order in perturbation theory for the 1S state and to fifth order for the general n, l = n – 1 quantum state. Results for the 2S states are also given. Comparison of the perturbation-theory results with those of numerical integrations for the energy show excellent agreement. It is shown that a finite screening radius gives rise to a finite number of bound states, a result that contradicts some recently published work. Application of the screened Coulomb potential model to intensity cutoffs in the spectra of solar and laboratory hydrogen plasmas is discussed. (auth)

Cosmic Radiation

Refer also to abstracts 45547, 46360, 46595, 46596, 46659, and 46685.

46293 (AECL–3378) COSMIC RAY NM-64 NEUTRON MONITOR DATA. XII. Monthly Graphs, January–April 1969. Steljes, J. F. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1969. 83p. Dep. CFSTI (U. S. Sales Only). CAN $2.00.

Uncorrected and barometer-corrected results from the cosmic-ray stations in Canada using equipment maintained by AECL are given in tabular form for the period from January to April 1969. Normalized graphs are given for the same period. The data for a flare increase on February 25 and a Forbush decrease at the end of April are given using a time resolution of five minutes. (auth)

46294 (ITF-69-44) HIGH-ENERGY COSMIC RAYS AND THE NEUTRINO SEA. Rekalo, M. P. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 29p. (In Russian). (CONF-690417-14). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

An influence of the neutrino sea, predicted in many models of the Universe, on the penetration of high-energy cosmic rays: protons, electrons, and neutrino, was investigated. It is shown that a known maximal energy of cosmic rays ($\sim 10^{20}$ eV) allows establishment of the upper limit of a Fermi energy of the neutrino in the Universe ($k_F < 0.1$ eV) that is three orders better than an earlier existing value. It is shown that high-energy electron penetration through the Universe defines itself essentially by the Fermi energy of the neutrino sea: if $k_F < 6.3 \times 10^{-30}$ eV, the Universe is opaque for an electron of any high enough energy, if $k_F = 10^{-2}$ eV, the Universe is transparent for electron energies in the interval 5×10^{20} eV to 8×10^{23} eV. It is shown also that study of an energy spectrum of the cosmic rays allows a check of the validity of a big-bang model of the Universe, and clears up the question of existence of anisotropic neutrino currents in the Universe. (auth)

46295 (UCRL-71653) INVESTIGATION AND COMPARISON OF RADIOGENIC ARGON, TRITIUM, AND ^{14}C IN ATMOSPHERIC RESERVOIRS. Schell, W. R. (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 14, 1969. 38p. (CONF-690817-1). Dep. CFSTI.

From Nobel Symposium, Uppsala, Sweden.

A study was started to determine the concentration of ^{37}Ar and ^{39}Ar in atmospheric samples. Since these radionuclides are cosmic-ray produced, the production rate in the atmosphere at any point should be dependent on the cosmic-ray flux. The concentration in samples collected should be dependent on the production from cosmic rays, the production from nuclear reactors, and nuclear detonations, and the air mass movement. The paper outlines basic problems in atmospheric reservoir mixing, and how measurement of samples for cosmic-ray produced argon can be utilized in environmental studies. New techniques were developed to separate and measure the low specific radioactivity of argon samples. Other gaseous radionuclides present in environmental air samples, HT, ^{14}C, Xe, and Kr, can be measured using the equipment. Details of the equipment design are included. The first results of the ^{37}Ar concentration indicate sufficient radioactivity to measure by high-pressure gas counting. (auth)

46296 ANISOTROPY OF THE COSMIC MICROWAVE BACKGROUND RADIATION. Dautcourt, G. Monatsber. Deut. Akad. Wiss. Berlin, 11: 231-5(1969). (In German).

The frequency dependence of the individual contributions to the anisotropy is theoretically developed. The results showed that the frequency dependence of the various contributions is identical to the anisotropic fraction of the 3°K radiation. (J.S.R.)

46297 THEORY OF COSMIC RADIATION OF EXTREMELY HIGH ENERGY. Helmis, G. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 11: 165-72(1969). (In German).

It is shown that it is possible to explain the acceleration of cosmic-ray protons to extremely high energies by means of a Fermi acceleration mechanism if one ascribes to the center of the galaxy a greater activity with respect to acceleration than the usual region of the galaxy. In the framework of this model, it is shown that up to the energy range 10^{16} eV for which the gyration radius of the particles is of the same order of magnitude as the mean expansion of recoiled clouds, the acceleration proceeds without significant influence from the center. In the transition region of 10^{16} eV, the acceleration is determined essentially by the center; there is also a power law with a greater exponent that for the subjacent energy region, in agreement with experimental results. Although the acceleration in this energy region proceeds essentially only in the center, the distribution at the location of the sun remains almost completely isotropic. At higher energies (10^{18} eV), a strong anisotropy is to be considered as a result of the strong increase of the diffusion coefficients with the energy. Farther in this energy region, the energy distribution does not follow a power law but it is to be expected that the particle flux decreases exponentially with ϵ^{-1}, when other acceleration and loss mechanisms are not responsible. Numerical estimations show that the observed phenomena can be evaluated to an order of magnitude. A larger activity of the center in contrast with the usual region of the galaxy is therefore possible. (tr-auth)

46298 A STUDY OF SOLAR AND COSMIC RADIATION FROM THE VENUS 4 SPACE PROBE. Vernov, S. N.; Chudakov, A. E.; Vakulov, P. V.; (and others). pp 203-14 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Solar and galactic cosmic rays and solar radiation near Venus were studied during the flight of the Venus 4 space probe. Equipment installed on Venus 4 made it possible to detect protons with energies of 1 to 5 MeV and electrons with energies higher than 100 keV, as well as primary cosmic radiation starting at energies of 30 MeV/nucleon. During the Venus 4 transit from Earth to Venus (128 days), eighteen bursts of 1 to 5 MeV solar rays were detected. Seven of these bursts exhibited considerable electron fluxes with energies of more than 100 keV. Quiet time intervals were used to measure proton background which decreased by more than an order of magnitude compared to 1965. Intensity of primary cosmic radiation increased by 30% during this period. Measurement of radiation in the Venus environment has shown a complete absence of Venus radiation belts. Intensity of trapped radiation near Venus is at least 10^6 times lower than that near the Earth. When approaching Venus, a decrease in the flux of primary cosmic radiation was recorded which was connected with geometric screening by the planet. The value of the cosmic-ray albedo from the Venusian atmosphere has been obtained. (auth)

46299 COMPOSITION OF COSMIC RAYS MEASURED IN GEMINI XI. O'Dell, F. W. (Naval Research Lab., Washington, D. C.); Shapiro, M. M.; Silberberg, R.; Stiller, B.; Tsao, C. H.; Durgaprasad, N.; Fichtel, C. E.; Guss, D. E.; Reames, D. V. pp 215-21 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

An oriented research nuclear emulsion detector capable of time resolution was exposed in Gemini flight XI to investigate the primary cosmic-ray nuclei above the Earth's atmosphere. This was the first satellite exposure of an emulsion apparatus designed to collect high quality tracks of heavy nuclei under a negligible thickness of matter (0.07 g/cm^2). Time resolution was obtained by moving a lower stack, consisting of emulsions of various sensitivities, with respect to a sensitive upper stack at the rate of 25 μ/min. It is thus possible to separate the "useful" tracks—formed during the oriented portion of the flight—from those formed at other times. It is also possible to correlate tracks with the varying geomagnetic rigidity cutoff. Data are presented on the relative abundances of individual chemical elements in the high-energy cosmic radiation above the Earth's atmosphere. Problems involved in relating the data to the Earth's geomagnetic field are described. (auth)

46300 A SPECTRAL MEASUREMENT OF THE COSMIC X-RAY BACKGROUND DOWN TO 2 keV. Green, D. W.; Wilson, B. G.; Baxter, A. J. (Univ. of Calgary, Alberta). pp 222-5 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

The cosmic x-ray background has been investigated in the 2- to 10-keV energy region from a rocket flight at Resolute Bay, N.W.T., a location close to the geomagnetic pole. The instrumentation consisted of two Xe-filled rectangular proportional counters, each of area 38 cm^2, with beryllium windows of 2- and 5-mil thickness. These detectors were mounted in a plastic scintillator anticoincidence shield and their field of view restricted to 0.12 ster by a rectangular fiberglass collimator. Results are presented for the x-ray energy spectrum, the efficiency and resolution of the detectors having been incorporated in the substantial data reduction. The relation of this measurement to other experiments is considered and the evidence for the cosmic origin of the background is examined. (auth)

46301 OBSERVATIONS ON DISCRETE X-RAY SOURCES. Buselli, G.; Clancy, M. C.; Davison, P. J. N.; Edwards, P. J.; McCracken, K. G.; Thomas, R. M. (Univ. of Adelaide). pp 226-7 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Results obtained from a balloon-borne experiment to study high-energy (7 to 167 keV) celestial x rays are described. The locations of several sources are given. (M.O.W.)

46302 A POSSIBLE INTERRELATION BETWEEN INTERSTELLAR AND INTERPLANETARY COSMIC DUST. Greenberg, J. M. (Rensselaer Polytechnic Inst., Troy, N. Y.). pp 111-15

of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

By considering the solar system to be passing through a standard interstellar cloud it may be shown that a significant fraction of the interplanetary particles contributing to the zodiacal light are of interstellar origin. The mass density of zodiacal particles in some models, e.g., Weinberg, is perhaps no greater than that in the reflection nebulosity around Merope and is only a factor of 100 greater than the average density of dielectric grains in the interstellar space within spiral arms. In order to account for an injection of interstellar dust which maintains the total zodiacal light component of the interplanetary material we need of the order of 100 tons per second and this order of magnitude is not unreasonable. The physical and dynamical processes of this problem are discussed. An alternative suggestion is made that the zodiacal light at high ecliptic latitudes may owe its origin in whole or in part to interstellar particles which arrive in such a way as to produce orbits of random inclination. A difference between the polarizing properties of the particles in and outside the ecliptic is predicted. (auth)

46303 DETERMINATION OF THE SPECTRA AND FLUX OF ATMOSPHERIC FAST NEUTRONS IN A QUIET-SUN PERIOD AND AT 46°N GEOMAGNETIC LATITUDE. Albernhe, F.; Talon, R. (Centre d'Etude Spatiale des Rayonnements, Toulouse. CNRS, Toulouse). Ann. Geophys., 25: 99-102(Jan.-Mar. 1969). (In French).

The flux and spectrum of fast neutrons (3 to 14 MeV) were measured during two balloon flights at 46° N geomagnetic latitude. The spectra obtained are $(dN)/(dE) = A\ E^{-b}$ with A = 0.39 ± 0.04 (I) 0.45 ± 0.01 (II) and b = 1.23 (I), 1.25 (II). The albedo neutron flux was extrapolated, values being 0.13 ± 0.012 for the first flight and 0.153 ± 0.003 for the second. (auth)

46304 ELECTRON COMPONENT OF COSMIC RAYS. Meyer, Peter. pp 205-16 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

Only in the past six years has the presence of electrons in the cosmic radiation been firmly established. Measurements at balloon altitudes made with electron spectrometers of new design have shown that the electron component is relatively insensitive to solar modulation, has less positive excess than simple theories predict, and exhibits a change in the power law spectrum at high energies. Further studies of cosmic-ray electrons may reveal the characteristics of the source of cosmic rays and the details of their storage mechanism in the Galaxy. (auth)

46305 COSMIC RAY NEUTRON STUDIES. Korff, Serge. pp 217-37 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

The neutron component of cosmic rays provides an important tool to investigate both the equilibrium of the nucleon component in the atmosphere and the fluctuations of the flux incident at the top of the atmosphere. Both these phenomena are surveyed, and a proposed method of long-term geological dating is discussed. (auth)

46306 NEUTRON EXPOSURE IN SUPERSONIC TRANSPORT. Wallace, Roger. pp 238-64 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

The exposure to cosmic radiation experienced by passengers and crew in a supersonic transport at 65,000 to 75,000 ft has been investigated. The problem is very complex due to the different dependences of the various cosmic-ray components upon altitude, the differences in tissue response to radiation, the large variations in cosmic-ray intensity, and the effects of the Earth's magnetic field. It appears that other supersonic transport problems are more serious than those of radiation exposure. (auth)

46307 EFFECT OF SOIL AND WATER ON COSMIC RAY NEUTRONS. Kastner, Jacob. pp 265-74 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

Liquid scintillators, nuclear emulsions, and thermoluminescent crystals have been used to measure environmental neutron flux between thermal and 10-MeV energy below ground, at ground level, at air–water interface, on towers and at airborne altitudes of 20,000 ft. Preliminary results are compared with previous work and with calculations using a modified SNARG computer program. (auth)

46308 COSMIC RAY NEUTRONS AND ^{14}C PRODUCTION. Gold, Raymond. pp 275-87 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

The natural production of radiocarbon by cosmic-ray neutrons has been observed experimentally. Proportional counters, filled with two atmospheres of nitrogen, have been employed to detect the exoergic $^{14}N(n,p)^{14}C$ reaction. Electronic pulse-shape discrimination is utilized to reject meson and photon-induced events. Proton-recoil measurements of the sea-level spectrum of cosmic-ray neutrons in the energy region 0.05 to 2.0 MeV have also been carried out using this detection system with three atmosphere fillings of hydrogen and methane. In general, the neutron flux per unit energy decreases monotonically with increasing energy. The resulting geophysical data are: 1. ^{14}C production rate: $(1.89 \pm 0.08) \times 10^{-7}$/sec/cm^3, 2. Slow neutron density: $(1.19 \pm 0.06) \times 10^{-8}$ n/cm^3, 3. Integral fast neutron flux (0.05 to 2.0 MeV): 2.3×10^{-3} n/sec/cm^2 for the air-land interface at the Argonne National Laboratory site (53°N. geomagnetic latitude). (auth)

46309 CHEMICAL COMPOSITION OF GALACTIC AND SOLAR COSMIC RAYS. McDonald, Frank B. pp 179-201 of Extra-Terrestrial Matter. Randall, Charles A. Jr. (ed.). DeKalb, Ill., Northern Illinois University Press, 1969.

From Conference on Extra-Terrestrial Matter, Argonne, Ill. See CONF-680329.

Recent developments in balloon-borne and space-borne dE/dx detectors, Cherenkov counters, and emulsions, and in laboratory fossil track studies, along with better measurements of fragmentation parameters, have yielded new data on stripped cosmic-ray nuclei from Z = 1 to 92. Relative nuclear abundances seem to differ significantly from the universal cosmic abundances. It is now possible to separate solar cosmic rays from galactic cosmic rays. There appears to be no unique accelerating mechanism, but instead, several mechanisms seem to make significant contributions. Although the details are not yet understood, these mechanisms must account for a total cosmic-ray energy of 10^{58} ergs and a supply rate of some 10^{42} ergs sec^{-1}. (auth)

46310 MUONS IN LARGE EXTENSIVE AIR SHOWERS. Earnshaw, J. C.; Orford, K. J.; Turver, K. E. (Univ. of Durham, Eng.). Can. J. Phys., 47: 1427-8(July 1, 1969).

An error in the data on the muon component of extensive air showers presented at the 10th International Conference on Cosmic Rays is corrected. The effect on the explanation of the anomalies in the muon data which involved an abnormally large transverse momentum is considered, and an alternative explanation for the persisting anomalies in the data is suggested. (auth) (Canada)

46311 VARIATION OF THE EXPONENT OF THE ELECTRON AND MUON DENSITY SPECTRA OF EAS. Firkowski, Ryszard (Inst. of Nuclear Research, Lodz, Poland); Gawin, Jerzy; Hibner, Juliusz; Bonczak, Ludwika. Nukleonika, 14: 131-8(1969).

More than 350,000 showers have been recorded by the Łódź experimental arrangement; for ca. 200,000 of them the detection condition was that the flux of charged particles hit at least one detector of the eight particular trays out of twelve (electron triggering); for ca. 150,000 showers the detection condition was that the flux of penetrating particles hit at least one detector of six arbitrary "fields" (group of eight detectors) out of nineteen existing (muon triggering). It was found that in both cases the density spectra of the respective particles can be approximated by a power law curve with a variable value of the γ exponent. For the electron coincidence this variation is as follows: $\gamma(x) = a \log x + b$, a = 1.340 ± 0.057, b = 0.968 ± 0.093; for the muon coincidence $\gamma(\rho) = a \log \rho + b$, a = 0.28, b = 2.07; and $\bar{\gamma} = 2.05 \pm 0.01$. (auth)

46312 PERIODIC SOLAR TIME VARIATIONS IN THE COSMIC-RAY MUON COMPONENT NEAR SEA LEVEL. Briggs, R. M.; Hicks, R. B.; Standil, S. (Univ. of Manitoba, Winnipeg). J. Phys., A (London), 2: 584-90(Sept. 1969).

Eight scintillation counters, each of about 1.5 m^2, were assembled in a muon telescope array at Winnipeg, Canada. Six telescopes (geometric factor about 750 cm^2 sr) had their axes approximately in the equatorial plane. For these, the asymptotic cones of accep-

tance were quite narrow with respect to asymptotic longitude, and they were therefore well suited for time variation studies. Two nearly vertical telescopes (geometric factor about 350 cm^2 sr) completed the array. Experimental results obtained between 13th November 1966 and 5th May 1968 are presented. It is shown that the phase of the average diurnal anisotropy is consistent with the Parker (1964, 1967) and Axford (1965) theories alone, and its amplitude is dependent on the time in the solar cycle. Further, a semi-diurnal anisotropy was found, extra-terrestrial in origin, with intensity maxima at right angles to the interplanetary magnetic field. (auth)

46313 SOME COMMENTS ON THE EXISTENCE OF A DENSITY GRADIENT OF THE COSMIC RADIATION PERPENDICULAR TO THE PLANE OF THE ECLIPTIC. Marsden, P. L. (Univ. of Leeds, Eng.). Ann. IQSY (Int. Years Quiet Sun), 4: 131-7(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The implications of a density gradient perpendicular to the plane of the ecliptic are discussed particularly in relation to seasonal and diurnal variations in cosmic-ray intensity. Experimental observations on these features are examined and it is concluded that there is reasonable evidence for the existence of the perpendicular gradient. (auth)

46314 GROUND-BASED SYNOPTIC OBSERVATIONS OF COSMIC RAYS. Carmichael, H. (Atomic Energy of Canada Ltd., Chalk River, Ont.). Ann. IQSY (Int. Years Quiet Sun), 4: 141-74(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The recommendations of the Sub-Commission on Cosmic-Ray Variations (SCRIV), made at Kyoto in 1961 and reported in COSPAR Information Bulletin No. 8 (pages 14 to 23), with regard to the world array of monitor stations have been accomplished. A world array of NM-64 neutron monitors (IQSY Instruction Manual No. 7) with counting rates nearly 50 times that recommended for IGY is functioning and is still being augmented. The increased power of these new monitors appears to be fully justified by the wealth of detail being revealed in the cosmic-ray variations. A satisfactory number of monitors of the IGY standard form are also still in operation. The most important gaps remaining in the coverage of the array are indicated. Substantial progress has been made in establishing a valid tabulation of magnetic rigidity cut-off values deduced from trajectory calculations; asymptotic cones of acceptance have been calculated and tables of variational coefficients are given for 98 stations in IQSY Instruction Manual No. 10. The use of computer techniques to produce contour diagrams of the time and directional variations of cosmic radiation as measured by the array of ground-based monitors is demonstrated and illustrated by three-dimensional diagrams. Results of latitude surveys in Europe in 1963 and in North America in 1965 and 1966 including exploration of the altitude variation on mountains and with aircraft are discussed. The attenuation coefficient of neutron monitor radiation at the time of the 1965 cosmic-ray maximum has been accurately determined as a function of altitude and geomagnetic cut-off rigidity. The differential or specific attenuation coefficient of neutron monitor radiation near sea level as a function of cut-off has also been determined and shown to be consistent near 2 GV with the value observed for the January 28, 1967 solar-particle event. Methods of correcting for meteorological effects on monitors have been tested and extended using data from the relatively undisturbed years, 1962 to 1966. In 1963 the amplitude of the diurnal variation in both meson and neutron monitors diminished and in 1965 it passed through a minimum. (auth)

46315 UNDERGROUND COSMIC-RAY MEASUREMENTS. Elliot, H. (Imperial Coll. of Science and Tech., London). Ann. IQSY (Int. Years Quiet Sun), 4: 175-80(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The present situation with regard to cosmic-ray solar and sidereal time variations underground is reviewed. The 12- and 24-hour solar waves observed at depths of 60 mwe or less can be broadly understood in relation to the known properties of the interplanetary magnetic field. The situation with regard to sidereal variation is still unsatisfactory in that there are as yet no completely consistent experimental results. Data from the southern hemisphere at 40 mwe depth favor a sidereal wave of amplitude about 0.045% with maximum intensity at 06h LST, whereas data from the northern hemisphere at 60 mwe indicate a variation of amplitude not more than 0.025% with maximum intensity at 17 to 20h LST. (auth)

46316 SOME OBSERVATIONS ON THE 11-YEAR MODULATION OF GALACTIC COSMIC RAYS. Webber, W. R. (Univ. of Minnesota, Minneapolis). Ann. IQSY (Int. Years Quiet Sun), 4: 181-6(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The recent extensive balloon and satellite measurements on the 11-year solar modulation of low-energy protons and helium nuclei were examined and compared. None of the presently accepted theoretical models for this modulation can satisfactorily explain all of the data. Specifically the diffusion–convection model cannot explain the observed dependence of the relative fractional modulation of protons and helium nuclei on the modulation level. Energy-loss models can partially explain this effect but run into other difficulties. It is suggested that other processes must play an important role in the 11-year modulation, for example, the extent of the modulation cavity outside the ecliptic plane and the motion of cosmic-ray particles in regions of high-solar latitude. (auth)

46317 IQSY OBSERVATIONS OF LOW-ENERGY GALACTIC AND SOLAR COSMIC RAYS. McDonald, F. B. (Goddard Space Flight Center, Greenbelt, Md.). Ann. IQSY (Int. Years Quiet Sun), 4: 187-216(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

It is most important that the study of low-energy cosmic rays be carried out at solar minimum when the effects of solar modulation are least. The spacecraft of the Zond, Luna, Proton, Pioneer, Mariner, OGO, and IMP series provided almost continuous coverage during the recent IQSY period. These missions have provided detailed, synoptic observations of both low-energy galactic and solar cosmic rays. Some of these studies are still in progress, so this paper seeks to summarize some of the more important developments. The hydrogen and helium energy spectra have been determined with great precision over the range 10 to 1000 MeV/nucleon. The relative modulation over this interval is well described by either a 1/R (where R is the particle rigidity) dependence or the equivalent $1/\beta$ (β = particle velocity relative to c, the velocity of light) dependence at low energies changing to a $1/\beta R$ dependence as one approaches 1 GeV. Observations of the cosmic-ray gradient out to 1.5 AU have proven to be a valuable addition to the spectral observations. Solar cosmic-ray studies with detectors of greatly increased sensitivity combined with lower energy thresholds have revealed a tremendous variety of observed events. (auth)

46318 COSMIC RAY VARIATIONS: THEORY. Dorman, L. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow). Ann. IQSY (Int. Years Quiet Sun), 4: 217-68(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

Integral multiplicity factors and coupling coefficients for meson, nucleon, and electron–photon components have been calculated on the basis of the modern ideas about nuclear–meson cascades of cosmic rays in the Earth's atmosphere with consideration of the energy spectrum of particles generated and their angular distribution and fluctuation. Calculations are performed relative to the primary nucleons, α particles, and heavier nuclei falling at different angles with respect to the zenith. Results of calculation in the region of smaller energies are compared with integral multiplicity factors and total coupling coefficients based on the geomagnetic effects of cosmic rays and the data on cosmic-ray variations. From the variation of the theoretical values obtained with the parameters characterizing conditions in the Earth's atmosphere it is possible to determine the partial barometric coefficients, densities, and temperature coefficients of the above-mentioned components. Data are presented on the coupling of solar activity with large-scale characteristics of the solar wind during the 11-year cycle. These characteristics are determined from measurements of the spectrum of protons and α particles in the region of nonrelativistic energies, from measurements of the radial and lateral gradients of intensity and anisotropy of cosmic rays in interplanetary space, and from the result of hysteresis investigations of 11-year and 27-day variations for particles of the galactic cosmic rays of different energies; this latter is determined from the modulation dynamic model by equalizing the anisotropic diffusion. As a result one can determine the dimensions of the region covered by the spiral-like field, the distance from the Sun to the effective boundary of the solar wind with the interplanetary magnetic field, the transport paths for scattering of particles of different energies, and characteristics of the regular and irregular components of the interplanetary magnetic field at different distances from the Sun up to 100 to 200 AU. The pure energy spectrum of the cosmic rays is beyond the limits of the solar system, thus proving that low-energy cosmic rays play a substantial part in confining the propagation of the solar wind. It is evident that during investigations of Sun–Earth relations, effected not through the direct influence of the Sun on the Earth but through processes taking place in inter-

planetary space, one should take into consideration the substantial lag of solar-wind characteristic changes at great distances with respect to the processes of solar activity which cause these changes. (auth)

46319 SOME PROBLEMS OF DETECTING GALACTIC ANISOTROPIES. Somogyi, A. J. (Central Research Inst. of Physics, Budapest). Ann. IQSY (Int. Years Quiet Sun), 4: 269-73(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

Attention is drawn to the fact that there are no observations concerning galactic anisotropies within the energy region 10^{11} to 10^{14} eV. At the same time, the importance of this energy region is emphasized. The second part of the paper deals with some general problems connected with the statistical methods of detecting periodicities. (auth)

46320 MODULATION OF COSMIC-RAY ELECTRONS. Hayakawa, S. (Nagoya Univ., Japan). Ann. IQSY (Int. Years Quiet Sun), 4: 274-8(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

It is emphasized that the mechanism of the solar modulation of galactic rays will be best studied through the observation of cosmic-ray electrons. If the knee of the electron spectrum at about 3 GeV is interpreted as due to the solar modulation, the spectra of electrons and nuclear particles are accounted for with a common modulation factor, $M(R) = \exp(-K/\beta)$ with $K = 2$ for $R \leq 0.6$ GV and $M(R) = \exp(-R_i/R\beta)$ with $R_i = 0.7$ for $R \geq 0.6$ GV. However, the conclusion has to be reserved on account of the absence of long-term variations of the electron intensity as recently observed by some groups. (auth)

46321 STUDIES OF MAGNETIC INHOMOGENEITIES IN INTERPLANETARY SPACE USING SOLAR AND GALACTIC COSMIC-RAY MEASUREMENTS. Charakhchyan, A. N. (Academy of Sciences, Moscow); Charakhchyan, T. N. Ann. IQSY (Int. Years Quiet Sun), 4: 119-30(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

Results obtained from stratospheric measurements of galactic cosmic-ray modulation are discussed in the light of theoretical considerations. The discussion leads to the following conclusions: 1. Almost the whole of the increase in the cosmic-ray intensity in the stratosphere during the period of decreasing solar activity (1960–1964) took place in a number of individual steps which followed each other at intervals of 6 to 12 months. This phenomenon is closely linked with corresponding decreases in solar activity as measured by the sunspot group number. 2. Several interesting cases were found when the fall in solar activity to a new stationary level took place rapidly (in several days). After such events on the Sun, the cosmic-ray intensity gradually increased and reached the stationary level in a period of about 2 months. The time, t_{st}, required for the amplitude of the cosmic-ray modulation in interplanetary space to reach its stationary value was about 40, 60, and 80 days after these events for the observations in 1961, 1963, and 1964, respectively. 3. Some data were obtained on the large-scale magnetic clouds which modulate the galactic cosmic rays in interplanetary space: (a) The velocity of propagation of these magnetic clouds $u \simeq 5 \times 10^7$ cm s^{-1}. According to the data on u and t_{st} the sphere around the Sun, within which the cosmic rays are modulated, has a radius $r = 10$ to 15 AU which depends little on solar activity. (b) The magnetic cloud density in space is either independent of the distance to the Sun or decreases significantly more slowly than for the case of radial propagation ($1/\xi^2$). (auth)

46322 GEOMAGNETIC AND COSMIC-RAY STORM OF MAY 25/26, 1967. Akasofu, S.-I.; Perreault, P. D.; Yoshida, S. (Univ. of Alaska, College). Solar Phys., 8: 464-76(Aug. 1969).

A series of geomagnetic disturbances and cosmic-ray variations caused by the McMath plage region 8818 in the latter half of May 1967 were examined. The systematic changes of the geomagnetic disturbances were observed as the relative location between the responsible flares and the Earth changed during the half solar rotation period. The storm of May 25/26, 1967, was then studied in great detail on the basis of records from a number of magnetic and cosmic-ray observatories. A large asymmetric main phase field in mid- and low-latitude regions (and thus an asymmetric ring current belt) grew rapidly during the first three successive polar magnetic substorms. The cosmic-ray intensity variations during the storm consisted of the Forbush decrease and the ring current effect. The Forbush decrease had a marked north–south asymmetry during its developing phase. (auth)

46323 DROP IN COSMIC-RAY INTENSITY AND THE STATE F THE F-REGION OF THE IONOSPHERE AND OF THE GEOMAGNETIC FIELD. Mizun, Yu. G. Kosm. Luchi, No. 10, 39-42(1969). (In Russian).

The states of the F region of the ionosphere and of the geomagnetic field are examined in relation to a drop in cosmic-ray intensity. (auth)

46324 PHASE JUMPS OF DIURNAL VARIATIONS IN COSMIC-RAY INTENSITY. Pankramov, A. K.; Vladimirskii, B. M.; Stepanyan, A. A. Kosm. Luchi, No. 10, 27-9(1969). (In Russian).

The phase jumps of the diurnal variation are considered on the basis of the data of the world-wide network of cosmic-ray stations for the IQSY period. (auth)

46325 ON THE POLARIZATION OF COHERENT RADIO SIGNALS FROM EAS. Castagnoli, C. (Univ., Turin); Silvestro, G.; Picchi, P.; Verri, G. Nuovo Cim., 63B: 373-84(Sept. 11, 1969).

The influence of the geomagnetic field on EAS radio emission is analyzed by simulating with a three-dimensional Monte Carlo the development of an electromagnetic cascade in the earth's magnetic field taking full account of Coulomb scattering. One computes for vertical showers at various heights the dipole moment M, the transverse current J, together with the negative charge excess e. A discussion of the radiation field shows that the geomagnetic effect is appreciably less than previously estimated and depends on frequency. The polarization of the observed signal decreases markedly with increasing frequency, which seems to agree with experimental data. (auth)

46326 PERIODIC VARIATIONS AND THEIR CHANGES DEPENDENT ON SOLAR ACTIVITY. Kolomeets, E. V.; Sergeeva, G. A.; Chumbalova, R. A. Kosm. Luchi, No. 10, 43-5(1969). (In Russian).

Plots are given of the energy spectra of 27-day variations and amplitude changes of 27-day variations as a function of solar activity. (W.D.M.)

46327 ABOUT THE STRUCTURE OF THE INTERPLANETARY SPACE ACCORDING TO THE DATA ON ANNUAL COSMIC-RAY VARIATIONS. Dorman, L. I.; Luzov, A. A.; Mamrukova, V. P. Kosm. Luchi, No. 10, 162-6(1969). (In Russian).

The data of the world cosmic-ray station network and of the aerological probes of the atmosphere during 1958, 1960, and 1963 were used to determine the annual variation of the intensity of the secondary component of cosmic radiation as a function of the Earth's heliographic latitude. The results are compared with the changes of the magnetic activity K_p-index and of the flocculi field area. The cosmic radiation intensity gradient for the plane normal to the ecliptic plane is computed and a dynamic description of the electromagnetic structure of space and of its changes in the course of the solar activity cycle is given. (auth)

46328 COSMIC RADIATION AND EVOLUTION: A LUNAR EXPERIMENTAL TEST. Gold, R. (Argonne National Lab., Ill.). Radiat. Eff., 1: 173-5(July 1969).

It is proposed that mineral samples from the lunar surface be examined for possible measurement of the long-term lunar cosmic-ray environment. Observation of radiation-induced tracks in suitable lunar specimens could reveal, in principle, the primary cosmic-ray fluence for an epoch comparable with the lunar age. Such data would provide quantitative bounds on the long-term variation of cosmic radiation in the vicinity of the Earth and thereby test necessary conditions for the hypothesis of cosmic-ray induced evolutionary effects from supernovae. (auth)

46329 ABOUT THE NATURE OF THE CHANGES IN COSMIC-RAY DIURNAL VARIATION DURING MAGNETIC STORMS WITH SUDDEN COMMENCEMENT. Vladimirskii, B. M.; Pankratov, A. K.; Stepanyan, A. A. Kosm. Luchi, No. 10, 46-9(1969). (In Russian).

The nature of the changes of cosmic-ray diurnal variation during magnetic storms with sudden commencement is considered. (auth)

46330 ONE POSSIBLE WAY OF EXPERIMENTAL DETERMINATION OF THE CROSS-SECTION OF NEUTRINO–NUCLEI INTERACTION. Domogatskii, G. V. Kosm. Luchi, No. 10, 136-8(1969). (In Russian).

A possibility is discussed of determining the cross sections of the reactions $\nu(\bar{\nu}) + z \rightarrow (z \pm 1) + e^{\mp}$ by measuring the cross sections of the processes $e^{\mp} + z \rightarrow (z \mp 1) + \nu(\bar{\nu})$. (auth)

46331 GALACTIC LINE EMISSION FROM 1 TO 10 keV. Silk, Joseph; Steigman, Gary (Inst. of Theoretical Astronomy, Cambridge, Eng.). Phys. Rev. Lett., 23: 597-600(Sept. 15, 1969).

The flux of x rays produced by low-energy cosmic-ray nuclei in HI regions is calculated. Electron capture to excited states by cosmic-ray nuclei of heavy elements, followed by cascades down to the ground state, are considered. It is found that the electron-capture processes may yield appreciable line intensities in the range 1 to 10 keV in the galactic plane. (auth)

46332 INSTALLATION FOR EXTRACTING RADIOACTIVE ARGON FROM CHLORINE-CONTAINING SUBSTANCE. Gavrin, V. N.; Kalinnikova, I. A.; Pomanskii, A. A.; Severnyi, S. A. Kosm. Luchi, No. 10, 20-2(1969). (In Russian).

An installation for extracting radioactive argon from a chlorine-containing substance is described. Design features and a scheme of the installation are given. (auth)

46333 POSITION OF THE SOURCE OF THE COSMIC RAY DIURNAL ANISOTROPY RELATIVE TO THE ECLIPTIC PLANE. Fischer, Stanislav (Inst. of Experimental Physics, Kosice, Czech.). Fyz. Cas., 19: No. 2, 114-17(1969).

The position of the source of the diurnal variation was investigated on the basis of data from cosmic-ray neutron monitors on Mawson and Churchill (1957–1967). Possible causes of the changes of this position during the 11-year cycle of solar activity are discussed. (JPRS)

Direct Energy Conversion

Refer also to abstract 46069.

46334 (EUR-4239) FABRICATION METHODS FOR AND STUDY OF SANDWICHES FOR THERMIONIC CONVERTERS: SURVEY AND PRESENT SITUATION. Fiebelmann, P. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center). 1969. 22p. (In German). Dep.

A survey is given on sandwiches intended to be used for different thermionic reactor concepts. Fabrication methods known to the author are mentioned. Some of the main features are tabulated. Characteristic values are recommended for sandwiches. Tests carried out at EURATOM, Ispra, are communicated. (auth)

46335 (IAE-1716) CALCULATION OF THE ELECTROMAGNETIC PARAMETERS OF MAGNETIC SYSTEMS WITH RIGHT-ANGLE COILS. Breev, V. V.; Kolyadin, N. M.; Panchenko, V. P. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1968. 70p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The calculation of electromagnetic parameters (the B/I ratio, inductance L, and ohmic resistance R) of magnetic systems is studied with reference to purposes of MHD energy conversion. A method of approximate analysis of those systems is presented. The main content of the paper is devoted to the elaboration of methods of numerical calculations of magnetic systems with rectangular coils. Typical results are presented of detailed calculations of the distribution of the magnetic field over the working volume and in the winding of a magnetic system, and an analysis is given of the influence of the geometric dimensions on the electromagnetic parameters. Corresponding tables were compiled for magnetic systems of various sizes. (JPRS)

46336 (INR-994) TIME RESPONSE OF THE RADIATION ELECTROCHEMICAL CELL. Zimek, Zbigniew; Zagorski, Zbigniew P. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 18p. (In Polish). Dep.

The approximate equivalent circuit of the electrochemical cell converting energy of ionizing radiation into electric current was established and its time characteristics calculated. On this basis, the possibilities of the cell as a sensor of short pulse of ionizing irradiation were analyzed, and the influence of cell parameters on the quality of measurement is discussed. (auth)

46337 (TEE-3874-7) THERMAL FLUX IN A RESEARCH PARAMETRIC CONVERTER. Lieb, D. (Thermo Electron Corp., Waltham, Mass.). June 30, 1969. Contract AT(30-1)-3874. 26p. (TE-4086-32-70). Dep. CFSTI.

Performance data for the thermionic converter are in their most useful form if they are independent of geometry. The corrections required to establish constant surface temperature can be assumed to be linearly related to the input power to the emitter. Because of the lower values of heat flux associated with dynamic (as opposed to static) data techniques, maintaining constant surface temperatures is much simpler with dynamic methods. Comparisons of the data obtained from the two methods show excellent agreement (10 mV or better) throughout the range of useful operation. Results from heat balance tests indicated a preliminary value of 2.1 watts/A for electron heating of the collector. This value is somewhat lower than expected and may be suspect because of thermocouple calibration variations. However, the electron heating of the collector was found to be proportional to collector current over a wide range of operating conditions in the power producing region. (auth)

46338 MEASUREMENTS OF THE TEMPERATURE OF PLASMAS IN MHD DUCTS AND COMBUSTION CHAMBERS BY RECORDING ABSOLUTE SPECTRAL LINE INTENSITIES. Sukever, Shymon (Inst. for Nuclear Studies, Swierk, Poland). Nukleonika, 14: 139-51(1969). (In Russian).

The theory of measuring plasma temperature in combustion chambers and MHD ducts by recording the absolute intensities (AI) of spectral lines with a large spontaneous emission coefficient (A_ig_i) is discussed. The accuracy of the method and its suitability for measuring the temperature of plasmas in MHD ducts are analyzed. The paper describes the experimental setup, which consists of a combustion chamber and an MHD duct, and presents a schematic diagram for temperature measurements by the AI method. A schematic diagram is also given for measuring the surface temperature of the electrodes in an MHD duct through the plasma by means of an optical pyrometer and using data obtained by recording the absolute line intensities and the absolute intensities of the continuum in the spectral region 6000 to 6500 Å. Plasma temperature measurements made by the absolute line intensity method and the results of electrode surface temperature measurements for different regimes of combustion chamber operation are given. (auth)

46339 STUDY OF VARIOUS METHODS OF DETERMINING THE TEMPERATURE OF THE PLASMA IN AN MHD DUCT. Sukever, Shymon; Litski, Yanush; Mizera, Barbara; Zhelyazny, Pavel (Inst. for Nuclear Studies, Swierk, Poland). Nukleonika, 14: 153-64(1969). (In Russian).

Measurements were made of the temperature of a plasma consisting of combustion products in an MHD duct. The measurements were made by a number of different methods: absolute spectral line intensity recording; sodium line reversal; a generalized method of spectral line inversion, and dynamic thermocouple. The experimental setup consisted of an oxy–acetylene combustion chamber and a small MHD duct. The conditions under which the measurements were made were similar to those in large experimental facilities. (auth)

46340 DIRECT CURRENT MHD GENERATORS WITH VARIABLE CONDUCTIVITY, VELOCITY, AND MAGNETIC FIELD. Roberts, John J.; Wessel, W. Roy; Petrick, Michael (Argonne National Lab., Ill.). J. Spacecraft Rockets, 6: 729-34(June 1969).

Since many liquid-metal MHD cycles will have generators with two-phase flow, whether by design or because of incomplete phase separation, numerical methods have been developed to describe Faraday generators with arbitrary axial variations in magnetic field, conductivity, and velocity. A computer program was written to implement these methods. Its output presents numerical calculations on various generator models both as tables of numbers and as directly produced film images of electrical potential lines and current lines. In this paper, some numerical results are compared to known analytical solutions for exponential field overhang, and the cases of linear and chopped exponential field overhang are investigated. Numerical results compare favorably with experiments on a two-phase flow generator. For two-phase flow generators, the axial variation in the induced voltage due to increasing void fraction is shown to be significantly detrimental to generator performance. Contouring the channel depth to maintain a constant fluid velocity can, however, alleviate this problem. (auth)

46341 SOME NEW RESULTS IN THE FIELD OF INDUCTIVE MAGNETOPLASMADYNAMIC (MPD) CONVERTERS. Peschka, W.; Holzchuh, R. Raumfahrtforschung, 13: 157-63(July-Aug. 1969). (In German).

Some results of theoretical work on MPD converters working in intermittent and continuous mode are presented. Some of the following results obtained from present investigations on the MPD generator are of importance for plasma propulsion systems. In the case of the intermittently working system, by use of a suitable time slope of the accelerating magnetic field (square wave impulse) an inductive propulsion system at a mean power level up to some kW with a pulse rate of approximately 1000 c/s and a duty ratio of about 1:1000 seems to be possible by use of radar-modulator techniques. (auth)

46342 PLASMA THERMOEMISSION CONVERSION OF ENERGY. Stakhanov, I. P. Moscow, Atomizdat, 1968. 392p. (In Russian).

The physics of low-temperature plasma which can be used in plasma thermoemission converters of energy is discussed. The various modes of operation of a converter are classified, and the transport theory for three-component plasma (electron, ion, and atom) is presented. The volt–ampere characteristics, density distribution, and the temperatures and electrical fields between electrodes under various conditions are studied. The methods used in the experimental studies are described, and the results of the computations entailed by the experiments are given. The effect of various impurities on the operation of a cesium thermoemission converter is analyzed. (auth)

Fluid Physics

46343 MAGNETOHYDRODYNAMIC BOUNDARY LAYERS. Eggenberger, Andrew J. (Univ. of South Carolina, Columbia); Hughes, William F. Z. Angew. Math. Phys., 20: 501-6(July 25, 1969).

A solution method is shown which is easily adapted to the MHD boundary layer problem and which is compatible with high speed computing machines. The method seems to be competitive with the current finite difference method and allows a more complete consideration of many aspects of boundary layer flows. The method used is the general method of integral relations previously suggested for solving the classical boundary layer equations. (M.H.R.)

46344 COMBINED FREE AND FORCED CONVECTION EFFECTS ON THE MAGNETOHYDRODYNAMIC FLOW THROUGH A CHANNEL. Gupta, Anadi Shankar (Indian Inst. of Tech., Kharagpur). Z. Angew. Math. Phys., 20: 506-13(July 25, 1969).

The forced flow of an electrically conducting fluid between two horizontal parallel plates with a linear axial temperature variation is discussed including the buoyancy forces. The fluid is assumed to be nonmagnetic so that phenomena like magnetostriction, etc., may be ignored. The flow takes place in the presence of a uniform vertical magnetic field. (M.H.R.)

46345 UNDE MAGNETOHYDRODINAMICE. (Magnetohydrodynamic Waves). Deutsch, R. V. Bucuresti, Editura Academiei Republicii Socialiste Romania, 1969. 215p.

This volume includes six chapters dealing with the magnetohydrodynamic wave theory, mathematical analysis of MHD flow and dispersion, weak MHD wave flow in monochromatic plane in the presence of homogeneous magnetic field, general theory of propagation of plasma, propagation of undulating MHD waves in inhomogeneous fields, deformation and perturbation of weak waves and MHD waves in high-intensity magnetic fields. 179 references. (R.V.J.)

46346 MAGNETOHYDRODYNAMIC FLOW DUE TO AN OSCILLATING INFINITE PLANE. Arora, K. L. (Punjab Engineering Coll., Chandigarh, India); Gupta, P. R. J. Math. Anal. Appl., 27: 534-44(Sept. 1969).

When a rigid body (insulator) immersed in a homogeneous, viscous, and electrically conducting fluid executes a coplanar simple harmonic motion, the flow thereby set up has a number of characteristic properties. A study is made here for the case when the fluid is bounded on one end by an infinite plane surface of the rigid body which executes vibrations relative to the body of the fluid. The problem is studied in two parts: (1) when the fluid extends to infinity, and (2) when the fluid is confined between the oscillating plane and a parallel insulating plane (fixed). (M.O.W.)

46347 ELECTROHYDRODYNAMIC INSTABILITY OF A CYLINDRICAL VISCOUS JET. Michael, D. H.; O'Neill, M. E. (University Coll., London). Can. J. Phys., 47: 1215-20(June 1, 1969).

The electrohydrodynamic instability to small axisymmetrical surface wave disturbances of a circular, cylindrical, electrically conducting, viscous jet, which is projected along the axis of a circular conducting cylinder is considered for the cases when the charges or potentials remain unaltered. The discussion given is applicable for arbitrary viscosities and it is shown that points of transition from stable to unstable modes of oscillation, or vice versa, are the same as for the inviscid jet. (auth)

46348 INTEGRAL FORMULA IN MAGNETOHYDRODYNAMICS. I. Agostinelli, Cataldo. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 45: 301-10(Nov. 1968). (In Italian).

The slow motion of an incompressible, inviscid fluid of high electric conductivity, plunged in a uniform magnetic field is considered. Moreover, the fluid is subjected to forces of a general nature, functions of place and of time. Equations for the velocity field vectors and for the pressure are developed. Finally, making use of the generalized formula of Kirchhoff, integral formulas are developed for the velocity components perpendicular to the applied magnetic field and the axial components of the vortex. (TSS) (auth)

46349 INTEGRAL FORMULA IN MAGNETOHYDRODYNAMICS. II. Agostinelli, Cataldo Atti. Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 45: 502-6(Dec. 1968). (In Italian).

The motion of the fluid in a fixed vessel with a rigid wall is considered, using results of Part I. New equations are derived for the motion, and utilizing the theory of the newtonian potential and the Clebsch theorem, the question is reduced to determining a vector, u, that satisfies the equation of the wave which propagates in the direction of the applied magnetic field, and finding an harmonic function of which the boundary values of the normal derivative are known. (auth)

46350 HYDROMAGNETIC PULSATIONS OF AN INFINITE CYLINDER. I. Bhatia, P. K. (Univ. of Jodhpur, India). Indian J. Phys., 42: 520-7(Sept. 1968).

Radial pulsations of an infinite fluid cylinder have been considered to include the combined effect of finite conductivity and variable density. It is found that, unlike the case of uniform density, the period is affected by finite conductivity. (M.O.W.)

46351 EFFECT OF A MAGNETIC FIELD AND CORIOLIS FORCES ON RAYLEIGH–TAYLOR'S INSTABILITY. Gandhi, J. M. (Univ. of Alberta, Edmonton. Univ. of Rajasthan, Jaipur, India). Can. J. Phys., 47: 1621-35(Aug. 1, 1969).

Variational principles are presented which characterize the solution of the equilibrium of a plane horizontal layer of an incompressible, electrically conducting fluid of electrical conductivity σ emu, of magnetic permeability K, having a variable density $\rho(z)$ in the vertical z direction, which is also the direction of gravity having acceleration g, and of viscosity $\mu(z)$ and which is rotating at Ω radians per second about the vertical axis in the presence of a horizontal magnetic field for the two cases: (i) When the electrically conducting fluid is assumed to be nonrotating ($\Omega = 0$), with the conductivity σ being finite and the horizontal magnetic field being uniform. (ii) When the electrically conducting fluid is assumed to be rotating ($\Omega \neq 0$), with the conductivity σ being infinite and the horizontal magnetic field being stratified. Based on the variational principles for these two cases, an approximate solution is obtained for the special case of a fluid of finite depth d stratified according to the law $\rho_0 = \rho_1 \exp \beta z$ (ρ_1 and β are some constants), for which kinematic viscosity v is assumed to be constant. Growth rate and total wave number of the disturbance are related by two cubic equations, and for simplified cases explicit solutions are obtained. The properties of hydromagnetic waves generated are discussed. (auth)

46352 ON HEAT TRANSFER IN MHD CHANNEL FLOW UNDER CROSSED FIELDS. Soundalgekar, V. M. (Indian Inst. of Tech., Bombay). Indian J. Phys., 42: 639-42(Nov. 1968).

An investigation of the combined influence of a magnetic field and an electric field on convective heat transfer in the fully developed laminar flow of an incompressible conducting fluid between parallel plates has been carried out, thus extending an earlier analysis of Siegal. (auth)

46353 HYDROMAGNETIC WAVES IN AN INFINITELY CONDUCTING COMPRESSIBLE FLUID WITH AN INHOMOGENEOUS MAGNETIC FIELD OF CONSTANT DIRECTION. Shah, S. K. D.; Srivastava, K. M. (Univ. of Jodhpur, India). Nuovo Cim., 63B: 105-14(Sept. 11, 1969).

Propagation of hydromagnetic waves in an inviscid, infinitely, conducting, compressible fluid, at rest in the equilibrium state, is studied in a linear approximation. The fluid is immersed in an inhomogeneous magnetic field of constant direction, normal to the direction of its variation. It is shown that two types of waves (i) Alfvén waves, with the local Alfvén velocity $V_A = H(x)/(4\pi\rho_0)^{\frac{1}{2}}$ and (ii) hydromagnetic waves with exponentially decaying amplitude propagate along the lines of force. In particular, it is shown that if the magnetic pressure $P = \alpha x$ + const, linearization of the equations is valid for all values of x and that waves of all frequencies and wave numbers, except $\omega/k = \sqrt{\gamma/3} \cdot C_s$, propagate throughout the medium. Also if $P = \text{const} + \beta \exp[-\alpha x]$, waves for all values of ω and k propagate throughout the medium. It is also found that the medium does not behave as a dispersive medium. (auth)

46354 ON MHD RAYLEIGH PROBLEM IN SLIP-FLOW REGIME. Soundalgekar, V. M.; Haldavnekar, D. D.; Dhavale, A. T.

(Indian Inst. of Tech., Bombay). Indian J. Phys., 42: 728-32 (Dec. 1968).

An analysis of the MHD Rayleigh problem under slip-flow boundary conditions was carried out under two conditions: (1) magnetic field fixed relative to the fluid, and (2) magnetic field fixed relative to the plate. Closed-form solutions were obtained for velocity and shearing stress. (auth)

46355 HEAT TRANSFER IN MHD COUETTE FLOW OF A RAREFIED GAS BETWEEN CONDUCTING WALLS. Soundalgekar, V. M.; Haldavnekar, D. D. (Indian Inst. of Tech., Bombay). Indian J. Phys., 42: 733-9(Dec. 1968).

An analysis of MHD heat transfer in Couette flow of a viscous incompressible rarefied gas between electrically conducting walls is presented. Temperature-jump boundary conditions are used to solve the differential equation. Expressions for temperature distribution and Nusselt number are obtained. The temperature profiles and Nusselt number are shown on graphs and conclusions are presented. (auth)

46356 ON MHD FLOW OF A RAREFIED GAS NEAR AN ACCELERATED PLATE. Soundalgekar, V. M.; Dhavle, A. T.; Haldavnekar, D. D. (Indian Inst. of Tech., Bombay). Indian J. Phys., 42: 740-5(Dec. 1968).

An analysis of MHD flow of an electrically conducting, incompressible, viscous rarefied gas past an accelerated plate is carried out when the magnetic field is fixed relative to the (a) fluid (case I) and (b) plate (case II). Expressions for velocity profiles and the drag are derived in closed form. It is observed that there is a decrease in velocity when there is an increase in the strength of the magnetic field and the rarefraction parameter h_1. An increase in h_1 leads to a decrease in the skin friction. An increase in the strength of the magnetic field leads to an increase in the skin friction in case (I) whereas in case (II), there is a decrease in skin friction. (auth)

46357 NOTE ON THE MOTION OF VISCOUS CONDUCTING LIQUID BETWEEN TWO CONCENTRIC ROTATING CYLINDERS IN THE PRESENCE OF A RADIAL MAGNETIC FIELD. Baral, M. C. (Tripura Engineering Coll., India). Indian J. Phys., 42: 681-4(Dec. 1968).

Flow of a conducting liquid between two rotating nonconducting infinite cylinders is studied. The response of the velocity of the liquid to a radial magnetic field is found to be transient in character. (auth)

Geophysics (Upper Atmosphere)

Refer also to abstracts 46185, 46193, 46323, and 46329.

46358 (NP-18006) ON THE METHOD OF DETERMINING THE MAGNETOSPHERIC ELECTRIC FIELD BY MEANS OF PARTICLE FLUX MEASUREMENTS. Note No. 224. Egidi, A.; Pizzella, G. (Rome Univ. (Italy). Istituto di Fisica). June 10, 1969. 11p. Dep. CFSTI (U. S. Sales Only).

Proton fluxes in various directions and in the energy range 100 eV to 50 keV were measured from a satellite on a geostationary orbit. The case of a geoelectric field directed along the radius from the earth center is considered. Only particle fluxes are considered whose trajectories are completely contained in the geomagnetic equatorial plane where the magnetic field is approximately given by $B = 0.312/r^3$ gauss with the geocentric distance r measured in earth radii. (M.O.W.)

46359 (NP-18009) ON THE DEFINITION OF THE GEOMAGNETIC L COORDINATE. Note No. 226. Pizzella, G.; Signorini, C. (Rome Univ. (Italy). Istituto di Fisica). June 17, 1969. 7p. Dep. CFSTI (U. S. Sales Only).

A new definition of the geomagnetic L coordinate is given that seems to give a good description of the properties of the particle motion in adiabatic approximation. According to this definition, the L parameter is identified as the inverse of the flux invariant (third adiabatic invariant) and has, roughly, the same numerical values that are obtained with the McIlwain definition, within the present approximations. (M.O.W.)

46360 IONIZATION OF THE LOWER IONOSPHERE UNDER THE INFLUENCE OF CORPUSCULAR RADIATION. Tulinov, V. F.; Shibaeva, L. V.; Yakovlev, S. G. pp 231-6 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Results on the intensity of corpuscular radiation measured by means of rockets at altitudes up to 90 to 95 km in the latitudinal zone from the equator to 60°S, are presented. The data obtained indicate that corpuscular radiation is present at altitudes below 100 km and must therefore be taken into account as a constantly acting ionization source in the lower ionosphere. The results of an estimate of the contribution of corpuscular radiation to the formation of the D-region of the ionosphere are given. (auth)

46361 A STUDY OF THE LOWER IONOSPHERE OVER THE GEOMAGNETIC EQUATOR AT THUMBA USING A LANGMUIR AND PLASMA NOISE PROBE. Prakash, Satya; Subbaraya, B. H.; Gupta, S. P. (Physical Research Lab., Ahmedabad, India). pp 237-45 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Langmuir probe and plasma noise probe measurements made on a rocket flight from Thumba during the evening twilight of February 2, 1968, a day characterized by large disturbances on the Sun, are presented. A comparative study of the results of this flight with the results of a flight carried out on March 12, 1967, which was a very quiet day, indicates that electron temperature greatly affects the nature of the E2-layer. The fluctuations in the Langmuir probe current (plasma noise) measured in the frequency range 70 to 1000 Hz show two distinct regions in the ionosphere where noise occurs. The nature of the noise in these two regions is quite different. In the lower region, the fluctuations seen in the height range 85 to 92 km are likely to be due to turbulence and in the 92- to 105-km range, due to turbulence and nonlocalized forces. In the higher regions the noise measured in the height range 155 to 173 km may be that produced by the rocket itself. But the noise measured in the height range 142 to 155 km is likely to be genuine and is produced by nonlocalized forces. The observed noise satisfied many conditions presented for electrostatic ion cyclotron waves. Therefore, these waves are likely to be of the electrostatic ion cyclotron type; a study of the nature of the plasma noise may lead to a better understanding of the forces that produce them. (auth)

46362 THE ELECTRON DENSITY PROFILE OF AURORAL LAYERS AS OBSERVED WITH ESRO ROCKETS AT KIRUNA. Jacobs, K. G.; Kist, R.; Rawer, K. (Ionosphaeren Inst., Breisach, Ger.). pp 246-55 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

In the ESRO program of rockets fired into aurora, local electron density was measured with an impedance probe during four flights, all at night in winter. The profiles obtained during ascent show more similarity to a very thick layer than was expected, the peak being above 100 km. During descent, with increasing distance from the center of the aurora, the profiles are quite complicated and similarity is poor. (auth)

46363 MASS SPECTROMETER MEASUREMENTS OF POSITIVE IONS AND NEUTRAL GAS BETWEEN 100 AND 233 km ABOVE ANDOEYA, NORWAY. Arnold, F.; Berthold, W.; Betz, B.; Laemmerzahl, P.; Zaehringer, J. (Max-Planck-Institut fuer Kernphysik, Heidelberg). pp 256-61 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

A quadrupole mass spectrometer was flown aboard a Dragon rocket on October 7, 1967 at 1132 CET (Central European Time). By switching the potentials of the ion source it was possible to measure both positive ions and neutral gas spectra intermittently with the same instrument, in the altitude range from 100 to 233 km. Density versus altitude profiles were derived for the main constituents He, O, N_2, O_2, Ar, and N^+, O^+, N_2^+, NO^+, O_2^+. Some other masses such as 17, 18, and 44, both neutral and charged, are related to contaminants outgassing from the rocket. Metal ions, Mg^+ and Fe^+, were observed at 106 km. (auth)

46364 ROCKET OBSERVATION OF THE IONOSPHERE IN TWILIGHT CONDITIONS. Hirao, Kunio (Tokyo Univ.); Oya, Hiroshi; Tohmatsu, Takao; Ogawa, Toshihiro. pp 262-6 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

The sounding rocket K-9M-20 was flown from Uchinoura at ground sunset time on October 20, 1966. The electron and positive ion densities and intensities of four dayglow emissions were observed in the altitude range between 80 and 350 km. The electron density was measured with impedance and resonance probes, and

the positive ion density with a Langmuir probe. The dayglow emissions observed were N_2^+ (3914 Å), O (5577 Å and 6300 Å) and N (5200 Å). During the flight the lower part of the ionosphere decayed rapidly as the radiation of the Sun faded out so that the apparent recombination coefficient between 120 and 200 km could be obtained. Interpretation of the simultaneous dayglow observation shows that the ionization production due to residual solar ultraviolet radiation was still competing with electron–ion recombination in the pertinent altitude range. The apparent recombination coefficient is re-evaluated by taking into account the ionization production rate of the solar ultraviolet radiation. (auth)

46365 THE EFFECTIVE ELECTRON-LOSS COEFFICIENT AT HEIGHTS OF 200 TO 400 km DURING INCREASING SOLAR ACTIVITY (1965 TO 1966). Shutte, N. M.; Knorin, I. A. pp 267-72 of Space Research, Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Values of the effective electron-loss coefficient at heights of more than 200 km were found to be equal to 0.5 to 2×10^{-3} sec^{-1} as a result of simultaneous rocket measurements of electron density and solar uv radiation absorption made in 1965–1966 at a solar zenith angle of about 80°. The height dependence of the electron-loss coefficient in 1966 changed from that of 1965. This change seems to be due to an increase of solar activity. (auth)

46366 IONOSPHERIC EFFECTS OF THE FASTER ROTATION OF THE UPPER ATMOSPHERE. Matuura, Nobuo (Radio Research Labs., Tokyo). pp 273-8 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

The effects of the ionospheric F2 layer on the rotation of both the neutral atmosphere and the ionized particles are theoretically investigated for a steady state. The results show that the faster rotation of the upper atmosphere detected from the variations in the satellite's orbital inclination can be explained by the present mechanism. (auth)

46367 A PRELIMINARY ROCKET INVESTIGATION OF VERY LOW FREQUENCY IONOSPHERIC RESONANCES. Barrington, R. E. (Defence Research Telecommunications Establishment, Ottawa). pp 279-86 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

A Javelin sounding rocket equipped with two large orthogonal dipole antennae, a vlf receiver, and a swept-frequency oscillator and pulser was flown at the Churchill Research Range in an attempt to stimulate and detect at least one of the natural resonances of the ionosphere that lie in the vlf band. The pulser and swept-frequency oscillator were connected to one of the dipole antennae and the vlf receiver was connected to the second dipole. The amplitude and the rate of change of frequency of the signal coupled through the plasma from the oscillator to the receiver showed no observable change at frequencies in the neighborhood of the lower hybrid resonance frequency. Average amplitude changes from sweep to sweep of greater than 40 dB were found as the aspect of the rocket changed. Immediately following the cessation of the signals from the oscillator, a burst of noise that had a lower frequency cutoff at the lower hybrid resonance was encountered on many sweeps. These results indicate that it is possible to stimulate, by artificial means, the lower hybrid resonance of the ionosphere, and to use the stimulated signals to determine the frequency of this resonance. (auth)

46368 IONOSPHERIC ELECTRON TEMPERATURE MEASURED BY A GYRO-PLASMA PROBE. Oya, Hiroshi; Aso, Takehiko (Kyoto Univ.). pp 287-96 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

The ionospheric electron temperature was deduced from the sheath thickness determined from the admittance value measured in gyro-plasma probe experiments carried out in 1966. The probe admittance is measured by using a source signal whose frequency is scanned through the range from 200 kHz to 16 MHz; the lower frequency limit is low enough to determine the sheath admittance which depends only upon the sheath thickness. The electron density values which are required for determining the electron temperature from the deduced sheath thickness are also obtained from the gyro-plasma probe experiment, simultaneously. Data analysis has been carried out for the two experiments performed by the ionospheric sounding rockets L-3H-2 and K-9M-21, which were launched at 1535 JST (Japanese Standard Time) on July 23 and 1100 JST on December 5, 1966, respectively. It is verified that this method of temperature determination is useful in this type of experiment. (auth)

46369 THE STRUCTURE OF THE TOPSIDE IONOSPHERE OVER JAPAN. Matuura, Nobuo; Ondoh, Tadanori (Radio Research Labs., Tokyo). pp 297-303 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Some preliminary results obtained from analysis of the night-time Alouette II topside sounding data received at the Kashima station, Radio Research Laboratories, during the period from October 6, 1966 to September 29, 1967 are reported. The average night-time structure of the topside ionosphere over Japan is given by electron density variations with respect to geomagnetic latitude at altitudes around 1500, 2000, 2500 and 3000 km, and also by electron density distributions with respect to altitude at five values of the invariant magnetic latitude, Λ. Some ionospheric parameters are determined from theoretically obtained electron density profiles that best fit the observations. The results show that the probable thermopause temperature increases from about 1000 to 1200°K in the lower-latitude region, $\Lambda < 50°N$, to about 1500°K in the region, $\Lambda \gtrsim 50°N$, and further that the plasma temperature varies from about 1000°K in the lower-latitude region to about 2500°K in the high-latitude region, $\Lambda > 60°N$. (auth)

46370 PARTICLE TRAPPING AND PLASMA OSCILLATIONS IN THE SATELLITE-DISTURBED IONOSPHERE. Liu, V. C. (Univ. of Michigan, Ann Arbor). pp 304-8 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Recent measurements of the ionosphere using satellites, e.g., Ariel I and Alouette I, II etc., have indicated apparent plasma oscillations of unknown origin. The oscillations monitored by Ariel I are of the low-frequency type and obtained when a Langmuir probe is inserted into the wake of a satellite; on the other hand, those obtained from the Alouette satellites, which are topside sounders of the ionosphere, are of the high-frequency type. Many discussions have been aroused in the literature and at the last COSPAR meeting as to the source of these anomalous oscillations especially the Alouette results. A satisfactory theory of the phenomenon does not seem to exist. A new hypothesis and theory pertaining to the origin and mechanism of the phenomenon in question has been proposed by Liu. The new theory starts with a recently obtained self-consistent solution of electric potential distribution in the near wake of a rapidly moving satellite that shows the presence of a negative potential valley. It argues from the principles of plasma physics that ionospheric ions of a certain energy range must be trapped and oscillating in the valley behind the satellite. A dispersion relation between the oscillation frequency and the wavelength of the oscillating ions is obtained, which appears to agree with the low-frequency oscillations monitored via Ariel I, being the correct order of magnitude. Qualitative results on the oscillations of electrons which are, of course, the high-frequency types associated with the oscillating ions are discussed. The geophysical significance of the theory is mentioned. (auth)

46371 SOME REMARKS ON THE ORIGIN OF LOWER HYBRID RESONANCE NOISE IN THE IONOSPHERE. Horita, Robert E.; Watanabe, Tomiya (Univ. of British Columbia, Vancouver). pp 309-14 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Two possible mechanisms will be suggested for the origin of the lower hybrid resonance (LHR) noise discovered by the Alouette I satellite. The first suggestion is that LHR noise might be an electrostatic wave phenomenon excited by nonthermal particles through the Landau instability process. It is shown that in the ionosphere there are electrostatic waves propagating at large angles to the Earth's magnetic field with frequencies in the vicinity of the lower hybrid resonance. It is also shown that an electrostatic wave propagating slightly off the direction perpendicular to the magnetic field can grow due to the Landau instability process which is excited by high-energy (~10 keV) electrons streaming along the direction of the magnetic field of the Earth. The growing electrostatic wave thus triggered is shown to have a frequency band with a sharp lower cutoff at the lower hybrid resonance frequency, in agreement with observation. The second suggestion is that certain types of LHR noise are similar in nature to the resonance spikes

in the Alouette topside ionograms. The mechanisms are not mutually exclusive but complementary to each other. (auth)

46372 RECENT RESULTS ON STUDY OF AURORAL X RAYS. Cambou, F.; Maral, G.; Treilhou, J.-P. (Centre d'Etude Spatiale des Rayonnements, Toulouse. CNRS, Toulouse). pp 317-26 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969. (In French).

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Two types of x-ray spectrometer have been designed to study the energy spectrum, spatial characteristics, and displacements of auroral zone x-rays. Data obtained from several balloon flights during summer 1967 in Iceland show that different types of precipitation occur during a 24-hour cycle. A classification is discussed. The energy spectrum is slowly varying during the 24-hour cycle with a softening soon after midnight and hardening from early morning to midnight. Rapid energy variations occur during midnight events and are detected on a 128-channel energy spectrum. Displacements of electron precipitation areas are shown to have speeds of 1000 to 1700 m/s. (auth)

46373 COORDINATED MEASUREMENTS FROM TWO MULTI-EXPERIMENT ROCKETS IN AN AURORA. Ulwick, J. C. (Air Force Cambridge Research Labs., Bedford Mass.); Baker, K. D.; Hegblom, E. R. pp 336-42 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Measurements were made of several related auroral parameters on two rockets flown within 30 sec at Churchill, Canada. Each rocket carried a comprehensive payload for the measurement of electron and ion density and temperature, primary and secondary electron flux and spectra, proton flux, x rays, and N_2^+ and O I light emissions. The rockets penetrated a dim, diffuse aurora (several kilorayleighs of 5577 Å emission) during the breakup phase. The incident electron energy flux did not change appreciably over most of the flight for pitch angles less than 90° and the spectra had an approximately exponential form with an e-folding value between 5 and 7 keV. The pitch-angle distribution was approximately isotropic over the upper hemisphere with a dropoff for higher pitch angles that is more pronounced at higher energies. Short time variations in the flux in general were not correlated at the two rocket positions. One, associated with a rapidly developing arc near one of the rockets, is observed to produce only local effects characterized by an increase in flux especially at lower energies. It is shown, however, that a short time increase in flux can also occur over an extended area accompanied by corresponding increases in hyperthermal electrons and electron temperatures. (auth)

46374 SIMILARITIES IN THE ANNUAL BEHAVIOUR OF THE STRATOSPHERE AND THE D AND E LAYER OF THE IONOSPHERE. Schwentek, Heinrich (Max-Planck-Institut fuer Aeronomie, Lindau, Ger.). pp 405-17 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

It is shown that at temperate latitudes there is a remarkable difference in the behavior of several atmospheric parameters between summer and winter. The results suggest that the atmosphere from the ground up to the E layer of the ionosphere should be considered as a whole and that the behavior of single parameters such as temperature, ionospheric absorption, electron density, etc., should be considered only as separate indications of a complicated overall change from summer to winter. It is pointed out that a complete system of parameters should be determined, including parameters of the Sun's radiation. In this association it is shown that the mean sunspot number R correlates rather well with the solar radio flux at 2800 MHz so that R can still be used as a long-time parameter of the Sun's activity until detailed and precise measurements of the solar radiation at 1216 Å and in the x-ray band (0.1 to 100 Å) are available. (auth)

46375 LOWER THERMOSPHERE IONS IN THE NIGHTTIME AURORAL ZONE. Horiuchi, G. (Japan Meteorological Agency, Tokyo). pp 433-41 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

Concentrations of ions and neutral minor constituents are estimated in the auroral zone taking into account ionization due to electron precipitation and the resulting bremsstrahlung. It follows that the N_2^+ density increases, the order of magnitude being about 10^4 cm^{-3} at 100 km. Then N is produced through the reaction $N_2^+ + O \rightarrow NO^+ + N$, and N concentrations of 10^9 cm^{-3} or so may last about 3×10^5 sec after the ionizing pulse. NO is also produced, but the concentration may not exceed 10^7 cm^{-3}. From these processes O_2^+ and NO^+ of about $10^5 \sim 10^6$ cm^{-3} are possible. As for negative ion formation, it is worth mentioning that O_3^- increases in the height region of 50 ~ 70 km through the O_3 increase that accompanies the electron impacts. The O_3^- may be converted rapidly to CO_3^-. (auth)

46376 TERMINAL VELOCITIES OF SMALL PARTICLES IN THE EARTH'S UPPER ATMOSPHERE. Shafrir, Uri (Tel-Aviv Univ., Ramat, Israel); Dittberner, G. J. pp 120-8 of Space Research. Volume IX. Champion, K. S. W. (ed.). Amsterdam, North-Holland Publishing Co., 1969.

From 11th Plenary Meeting, Tokyo, Japan. See CONF-680530-(Vol.9).

When converting particle numbers, collected with the aid of balloons and rockets, into micrometeorite fluxes, the settling (terminal) velocities of these particles in the upper atmosphere enter the computations critically. The expected number of collected particles, per given size range, varies widely when different equations of motion are used. In particular, the exact form of the drag force to be used has been debated for some time. Previous experimental and theoretical investigations into this problem are reviewed, and the various terms describing the drag on the particles in question are evaluated. (auth)

46377 AURORAL X-RAY AND ATMOSPHERIC OZONE: A PRELIMINARY CONSIDERATION. Sekihara, K. (Meteorological Research Inst., Tokyo). Ann. Geophys., 25: 269-74(Jan.-Mar. 1969).

In order to explain the decrease of ozone in the auroral zone during a strong geomagnetic storm, the ionizing effect of bremsstrahlung auroral x-rays was treated quantitatively. The ionizing effect at 40 to 60 km is at least one order larger than that at 30 km. The order estimation of the reaction rate, including ion chemistry, was done and it is found that the ionizing effect will cause ozone decrease by the process of NO-molecule production. (auth)

46378 INFLUENCE OF THOMSON SCATTERING ON IONOSPHERIC MEASUREMENTS OF NON-MAXWELLIAN ELECTRON DISTRIBUTION. Waldteufel, P. (Centre National d'Etudes des Telecommunications, Issy-les-Moulineaux, France). Ann. Geophys., 25: 381-3(Jan.-Mar. 1969). (In French).

An investigation of the ionic Thomson scatter spectrum when a small percentage of suprathermal electrons is included in the electron velocity distribution shows that this spectrum is almost unaffected by hot electrons. It is suggested that this situation may occur in the ionospheric E region and explain the disagreement between Thomson scatter and probe measurements of the electron temperature. (auth)

46379 SPACE RESEARCH. VOLUME IX. Proceedings of the Eleventh Plenary Meeting of COSPAR, Tokyo, 9-21 May 1968. Champion, K. S. W.; Smith, P. A.; Smith-Rose, R. L. (eds.). Amsterdam, North-Holland Publishing Company, 1969. 785p. $33.60. (In English and French). (CONF-680530-(Vol. 9)).

Separate abstracts were prepared for 22 of the included papers; the remaining papers were not in scope. (M.O.W.)

For abstracts of individual papers see: 46298–46302 and 46360–46376.

46380 CALCULATION OF THE DETECTION LIMITS IN SITU OF AURORAL ELECTRONS. Clapie, M.; Reme, H. (Centre d'Etude Spatiale des Rayonnements, Toulouse. CNRS, Toulouse). Ann. Geophys., 25: 103-12(Jan.-Mar. 1969). (In French).

Study of slow auroral electrons of energy E (≤1 KeV) and of pitch angle near 90° is delicate because of secondary electron emission by the rocket body. A calculation of the incident-particle trajectories allows the determination of the detection threshold versus the rocket position in the Earth's magnetic field. When both primary and secondary electrons are detected, a particular method is elaborated to determine the contribution of each particle. (auth)

46381 BIMODAL DIFFUSION IN THE EARTH'S MAGNETOSPHERE. III. ON THE PROTON BELT. Theodoridis, George C. (American Science and Engineering, Inc., Cambridge, Mass.). Ann. Geophys., 25: 113-18(Jan.-Mar. 1969).

Acceleration of trapped protons through bimodal diffusion can account for high-energy trapped protons in the inner-belt region. The effects of bimodal diffusion are less obvious for the low-energy proton intensity profiles, but are of consequence at high values of L. For the most part, low-energy protons can be accounted for by constant-μ diffusion acting alone. The widely

different spatial patterns and temporal behavior displayed by the proton and electron belts can be understood as resulting primarily from different ratios of constant-E to constant-μ diffusion rates for the two-particle species. (auth)

46382 BIMODAL DIFFUSION IN THE EARTH'S MAGNETOSPHERE. IV. ON THE SPACE AND TIME DEPENDENCE OF TRAPPED PARTICLE ENERGY SPECTRA. Theodoridis, G. C.; Paolini, F. R.; Frankenthal, S. (American Science and Engineering, Inc., Cambridge, Mass.). Ann. Geophys., 25: 119-24(Jan.-Mar. 1969).

The general pattern of the L dependence of trapped-particle energy spectra in the presence of bimodal diffusion consists of a domain at low L's where spectra become softer with increasing L and a region at higher L's where spectral hardness is independent of L. The L shell of transition between the two regions and the absolute values of the spectral parameter E_0 (approximate e-folding energy of the integral particle intensity) depend primarily upon the energy spectrum and the location of the particle source as well as the ratio of constant-E to constant-μ diffusion rates. Sequences simulating geomagnetic events produce spatial and temporal patterns of trapped-particle energy spectra very similar to those actually observed in the radiation belts. (auth)

46383 THEORY OF POLAR SUBSTORMS. Pudovkin, [M. I.]; Shumilov, [O. I.] (Leningrad Univ.). Ann. Geophys., 25: 125-34 (Jan.-Mar. 1969).

The interaction between the magnetized plasma stream and the geomagnetic field is considered. It is noted that, in a general case, the current sheet may move along the surface of the magnetosphere at a speed different from that of the undisturbed stream. As a result, the electric field produced by the passing stream of magnetized plasma may penetrate into the magnetosphere. Numerical integration of equations of motion of charged particles within the crossed homogeneous electric and dipole-like magnetic fields is carried out. The location and size of the instant auroral zone, the diurnal variation of azimuths of auroral arcs, the energy of the precipitating particles, and their velocity are obtained. (auth)

46384 LUNAR TIDAL OSCILLATIONS IN f_0F_2 AND h'F AT HUANCAYO DURING IGY/IGC. Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Ann. Geophys., 25: 73-84(Jan.-Mar. 1969).

The lunar daily (L) oscillations at fixed lunar ages and lunar monthly (M) oscillations at fixed solar hours of f_0F_2 and h'F at Huancayo for individual seasons of IGY/IGC and results are compared with corresponding oscillations in H at Huancayo for the same period. Chapman's phase law is fully applicable for lunar oscillations in f_0F_2 but not for the oscillations in h'F. $L_2(f_0F_2)$ amplitudes are least during J months and largest during D or E months, and for any particular season, the amplitude is about twice in 1957-59 what it was in 1951-55. The phase of L_2 oscillation for any particular season remains constant with solar cycle and for any epoch advances progressively from J to E and D months through about 45°. All these features are analogous to that observed in H except that the L_2 oscillations in H and f_0F_2 remain opposite in phase. The M_2 oscillations in f_0F2 are most pronounced at noon and at evening hours while the same in H has a single maximum at noon and in h'F large and significant amplitudes are observed only between 18 to 24 hours. During the J months the maximum displacement $M_2(f_0F_2)$ oscillation for different solar hours occur at same lunar age rather than same lunar time, in analogy to M_2 oscillations reported earlier for H. The M_2 oscillation in h'F are large only during the period when h'F itself is greatly increased. It is concluded that the lunar tidal oscillation in f_0F_2 near the magnetic equator are very intimately connected with the corresponding oscillation in H and thereby with the equatorial electrojet currents. (auth)

46385 FIRST-ORDER IONOSPHERIC DOPPLER EFFECT. Bertel, L. (Laboratoire de Radioelectricite, Rennes, France). Ann. Geophys., 25: 85-91(Jan.-Mar. 1969). (In French).

First-order ionospheric Doppler shift has been considered, until now, only in particular cases using different electronic profiles. A review of this study in a most general case shows clearly the influence of horizontal gradients and gives a new method for the determination of the total electron content. The measurement of the ionospheric Doppler shift by the use of two coherent frequencies transmitted from the ionospheric or geodesic satellites Beacon, Diadème, or Transit has made possible the determination of the total electron content by applying the method described in this paper. (auth)

46386 UTILIZATION OF DIADEME SATELLITES FOR DETERMINATION OF ELECTRON CONTENTS. Bertel, L.; Castrec, C. (Laboratoire de Radioelectricite, Rennes, France). Ann. Geophys., 25: 93-8(Jan.-Mar. 1969). (In French).

The ionospheric Doppler shift measurement leads to interesting experimental results which complete those obtained by Faraday rotation. Two coherent frequencies (150 and 400 MHz) transmitted from French satellites Diapason, Diadème I and Diadème II were received at Doppler tracking stations included in a program of geodesy. The measurements presented were obtained in 1967 from the satellites Diadème I and II at Stephanion in Greece (37° 45′ N, 22° 49′ E). The measurement of the Doppler shift is obtained by counting for 10 seconds the numbers N_{400} and N_{150} of cycles received on the two frequencies. The expression $-(9/55)(N_{400} + (8/3)N_{150})$ supplies the cycle number, reported to 400 MHz, that describes the ionospheric effect. The accuracy of measurement by Doppler receiver is of the order of 0.01 Hz for each frequency. For each revolution, experimental curves of Doppler shift and parameters defining the satellite passage in the neighborhood of the receiver: elevation E, slant range D from the satellite to the station, cinematic Doppler shift Δf_C, time, ... are available. (auth)

46387 SYNOPTIC OBSERVATIONS OF THE F2 LAYER IN THE CONJUGATE MAGNETIC REGIONS OF KERGUELEN AND ARKANGELSK. Benkova, N. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow); Boukin, G.; Kerblay, T.; Davoust, C.; Taieb, C. Ann. Geophys., 25: 67-71 (Jan.-Mar. 1969). (In French).

Simultaneous ionospheric observations in the two conjugate region of Arkangelsk (U.S.S.R.) and Kerguelen (France) are studied. Differences between f_0F2 and the monthly mean of f_0F2 are compared for three pairs of stations. Two types of correlation are obtained: (1) the variations of differences are in phase at both hemispheres when in magnetic and ionospheric disturbed periods; (2) the variations of differences are in antiphase when the magnetic activity is low. During quiet periods no correlation is visible. (auth)

46388 DOPPLER EFFECT IN DECAMETRIC WAVES PRODUCED BY AN ACOUSTIC WAVE TRAVELING IN THE IONOSPHERE. Broche, P. (Laboratoire de Physique de l'Exosphere, Paris). Ann. Geophys., 25: 47-54(Jan.-Mar. 1969). (In French).

Local variations of electronic density due to acoustic waves traveling through the ionosphere were studied, and an order of magnitude of the resulting Doppler effect for a hf radio wave was calculated. In the E region, it is shown that the most important contribution comes from those parts of the radio wave tangent to the acoustic wave and that the Doppler shift is inversely proportional to the wave frequency. Conclusions have also been drawn for a radio wave reflecting in the perturbed region. (auth)

46389 SUCCESSIVE DEVELOPMENT OF ELECTROMAGNETIC (UHF AND VHF) AND LIGHT EMISSIONS DURING MAGNETIC SUBSTORMS. Vigneron, Jacques (Groupe de Recherches Ionospheriques, Paris); Karczewski, Jean Francois; Laurent, Georges; Lacourly, Sylvaine; Kleimenova, Natalia; Raspopov, Oleg; Roldougin, Valentin; Troitskaya, Valeria. Ann. Geophys., 25: 385-9(Jan.-Mar. 1969). (In French).

A series of events recorded at Sogra and Palovo (about 30 km from Sogra) permitted a study of the following: slow magnetism, uhf and vhf emissions, and aurorae. A relation between the Pi1 irregular geomagnetic pulsations comprising the "short irregular pulsations" (S.I.P.) and auroral agitation (A.A.), the auroral pulsations, and vhf emissions confirmed the differentiation of S.I.P. and A.A. and defined the specific correlations between Pi1 and vhf emissions. (TSS)

46390 RELATION OF AURORAL-ZONE MICROPULSATIONS TO MAGNETOSPHERIC SUBSTORMS. McPherron, Robert Lloyd. Berkeley, Calif., Univ. of California, 1968. 338p.

Thesis.

Results presented here are used to generalize the models of the auroral and magnetic substorms to include micropulsations occurring in the auroral zone on the night side of the Earth. Typical characteristics of magnetic substorms are described. Four types of auroral zone micropulsations occurring on the night side of the earth during magnetic substorms are described. These include: Sweepers (IPDP), Irregular Pulsations (Pi 2), Noise Bursts (Pi 1 and Pi 2), and Band Limited Pulsations (Pi 1). (Disser. Abstr.) (TSS)

46391 LUNAR OSCILLATIONS IN THE D-REGION ABSORPTION AT SINGAPORE. Chakravarty, S. C.; Rastogi, R. G. (Physical Research Lab., Ahmedabad, India). Nature (London), 223: 939-40(Aug. 30, 1969).

The results of some lunar semimonthly variations in the moon values of radio-wave absorption, averaged for the frequencies

2.0, 2.4, and 2.6 MHz, at Singapore during the period April 1951 to May 1955 are described. From these results it appeared that the lunar tides in the D and F regions of the ionosphere over Singapore have almost opposite phases. The tidal behavior on the F region for Singapore, which lies close to a transition region, is equatorial in nature, whilst the variation in the D region is of the high-latitude type. (UK)

46392 HYDROMAGNETIC RADIATION FROM ELECTRIC AND MAGNETIC DIPOLES IN THE MAGNETOSPHERE. Sundaram, A. K. (Langley Research Center, Hampton, Va.). Can. J. Phys., 47: 1643-56(Aug. 15, 1969).

The radiation characteristics of elementary electric and magnetic dipoles in a homogeneous, anisotropic, cold plasma of infinite extent with a uniform magnetostatic field are discussed. The cases treated include the electromagnetic sources taken parallel and perpendicular to the magnetostatic field. In all cases expressions for the field components are obtained that are valid at frequencies well below the ion cyclotron frequency. It is found that electric and magnetic dipole sources when oriented perpendicular to the magnetic field excite both ordinary and extraordinary modes. For the ordinary mode, the waves are guided in both directions within cones of small apex angle aligned with the static field. When the dipole sources are aligned with the magnetic field, it is found that the electric dipole excites only the ordinary mode leading to guided wave propagation, while the magnetic dipole excites only the extraordinary mode. In all cases, the waves propagate at Alfvén speed. The radiation characteristics are isotropic for the extraordinary mode excited by the perpendicular electric dipole and are nearly isotropic for the aligned magnetic dipole. For other cases the radiated power is concentrated in opposite directions along the static field. (auth)

46393 SOME OBSERVATIONS OF TWILIGHT He (1.083) EMISSION. Harrison, A. W. (Univ. of Calgary, Alberta). Can. J. Phys., 47: 1376-80(July 1, 1969).

The 1.083-μ resonance line of HeI has been observed in the evening twilight airglow spectrum over the period February 1968 to February 1969. A winter maximum of ~1.0 kR and a summer minimum of ~0.4 kR is found for the absolute brightness of the HeI line for a zenith angle of observation = 80° in the solar azimuth and for a solar depression angle = 15°. An analysis of several winter twilight decays showed that the decay pattern is not constant. Comparison of the observed brightness and shadow height variations with solar depression angle indicates a maximum volume emission rate in the height range 400 to 600 km. (auth)

46394 POLAR AURORAL AND MAGNETIC SUBSTORMS: THEIR MORPHOLOGY AND RELATION TO THE RING CURRENT. Meng, Ching-I. College, Alaska, Univ. of Alaska, 1968. 321p. Thesis.

There are four topics in this work, (1) magnetic storms in low latitudes, (2) polar substorms, (3) the relation between polar substorms and the growth of the ring current, and (4) the polar cap aurora during magnetic storm sudden commencement. The growth and decay of the geomagnetic storm of April 17–18, 1965 and Sept. 13, 1957 is studied by using world wide magnetic records. In particular, the asymmetric growth of the main phase decrease is studied in detail. For the storm of April 17–18, 1965 results from simultaneous satellite observations are also discussed. It is shown that the polar electrojet which causes polar magnetic substorms in high latitudes usually flows westward in all longitudes along a closed oval curve (the auroral oval). The strength of the polar electrojet is not uniform along the oval; some of the excess current flows across the polar cap; the remainder departs from the afternoon sector and crosses the midnight meridian to complete its circuit by joining the main westward flow in the morning sector. The study of magnetic disturbances in the evening sector, during polar substorm shows that the "negative bay" in middle and low latitudes, which had been thought to be due to the westward return current of the SD current system, is caused by the growth of the asymmetric storm-time radiation belt (the ring current), simultaneously with the polar substorm. A study of all-sky camera data from polar cap stations reveals the occurrence of two kinds of auroras in the polar cap: sun-aligned arcs which appear during magnetically quiet times, and active auroras which seem to be a part of the poleward expansion of the auroral substorm. Based on the morphology of polar substorms and the development of the ring current, models and mechanisms related to the energy transfer into the magnetosphere and the development of the polar substorm are discussed. The interchange instability of the ring current is a favorable mechanism for producing the polar substorm. (Diss. Abstr.)

46395 THE OGO-V PLASMA WAVE DETECTOR: INSTRUMENTATION AND IN-FLIGHT OPERATION. Crook, Gains M.; Scarf, Frederick L.; Fredericks, Robert W.; Green, Ira M.; Lukas, Paul (TRW Systems Group, Redondo Beach, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Geosci. Electron., GE-7: 120-35(Apr. 1969).

The Orbiting Geophysical Observatory, OGO-V, plasma wave detector is described. It was designed to make exploratory measurements of the properties of many electromagnetic wave modes (containing E and B components) and electrostatic wave modes (E components only) in the plasma region extending from beyond the upper ionosphere of the earth to the solar wind. The experiment examines the role of wave excitation and wave-particle interactions in providing both a dissipation mechanism for the collisionless bow shock and a scattering process that makes the solar wind behave as an effective fluid. It also examines the role of waves in producing stochastic particle acceleration, diffusion, and scattering within the magnetosphere and magnetosheath. The measurements will allow analysis of the characteristics of discrete emissions, hiss bands, and radiative signals produced by organized groups of charged particles throughout these regions. The instruments are designed to measure electric field components in the frequency range 200 Hz to 70 KHz, using a variety of short capacitively coupled antennas. In addition, the experiment has triaxial search coils, and onboard E–B correlations are performed to aid in distinguishing between the two types of waves. An account of the in-flight operation is presented. (BBB)

46396 PHYSICS OF INTERPLANETARY PLASMA AND LABORATORY EXPERIMENTS. Podgornyi, I. M.; Sagdeev, R. Z. (Inst. of Cosmic Studies, Moscow. Inst. of Nuclear Physics, Moscow). Usp. Fiz. Nauk, 98: 409-40(July 1969). (In Russian).

The available data indicate that the solar wind consists of a completely ionized hydrogen plasma with a concentration of 5 to 6 cm^{-3}, and a velocity of 3 to 5×10^7 cm/sec. The electron temperature exceeds the ion temperature by a number of times. The magnetic field tension at an Earth's orbit is about 10^{-4} oersteds. The interaction of the solar wind with this magnetic field is of fundamental interest, and can be studied under laboratory conditions with proper modeling. For example, the existence of belts of charged particles in the earth's atmosphere could have been predicted from laboratory experiments on plasma trapping. The parameters of a plasma flux which satisfy the modeling of the interaction of the solar wind with the Earth's magnetic field are listed as a velocity of 3×10^7 cm/sec, a concentration of 10^{13} cm^{-3}, and electron temperature of 20 eV, a magnetic field of 30 to 40 oersteds, a magnetic field size of 50 cm, and an ion temperature of 3 to 5 eV. Plasma and magnetic field parameters in model experiments are presented in dimensionless terms. Modeling of a collision-free shock wave at the boundary of the magnetosphere is discussed along with modeling of turbulent phenomena in the solar wind. Formation of a neutral layer at night is also discussed. (TTT)

46397 MAGNETOSPHERIC SUBSTORM. Anderson, K. A. (Univ. of California, Berkeley). Ann. IQSY (Int. Years Quiet Sun), 4: 62-4(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

A short note pointing out that several types of particle precipitation into the auroral zone occur throughout the day, each at a specific local time. These episodes are found to be simultaneous with auroral substorms in the midnight sector. (auth)

46398 THE EARTH'S RADIATION BELTS. Vernov, S. N. (Moscow State Univ.). Ann. IQSY (Int. Years Quiet Sun), 4: 281-301(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

A fairly detailed review is given on the radiation belts, their properties, particle sources, and dynamics. An extensive list of references is included. (W.D.M.)

46399 COMMENTS AND SPECULATIONS CONCERNING THE RADIATION BELTS. McIlwain, C. E. (Univ. of California, San Diego, La Jolla). Ann. IQSY (Int. Years Quiet Sun), 4: 302-6 (1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

Care must be taken not to adhere too rigidly to initial theoretical models or assumptions of artificial boundaries; theories must be followed by careful experiment, often with simultaneous observations at a large number of locations. The author speculates on the origin of the particles, the mechanism of their acceleration, and of their diffusion during quiescent periods between storms. (auth)

46400 SOME QUANTITATIVE ASPECTS OF ELECTRON PRECIPITATION IN AND NEAR THE AURORAL ZONE. Bailey, D. K. (Environmental Science Services Administration Research Labs., Boulder, Colo.). Ann. IQSY (Int. Years Quiet Sun), 4: 307-8(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

Daytime intensity decreases of radio signals propagated by ionospheric forward scattering are caused by abnormal ionization below the scattering region. One of the causes of this is electron precipitation from the vicinity of the boundary of the trapping region. Postulation of exponential energy spectra for the precipitating electrons explains these forward scatter observations on one of the scatter paths near the auroral zone and also explains observations of auroral bremsstrahlung x rays on the other scatter path. (auth)

46401 PHENOMENOLOGY AND MORPHOLOGY OF AURORAE. Feldshtein, Ya. I. (Inst. of Terrestrial Magnetism, Ionosphere, and Radio-Wave Propagation, Moscow); Isaev, S. I.; Lebedinskii, A. I. Ann. IQSY (Int. Years Quiet Sun), 4: 311-48(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The space–time distribution of discrete aurorae in the polar cap and of the zone aurorae is discussed. Special attention is paid to the dynamics of the association of aurorae with polar magnetic disturbances and ring currents in the magnetosphere. A scheme of the dynamical morphology of aurorae including the observed regularities in their movement accompanied by the appearance, development, and extinction of polar magnetic disturbances is presented for the northern hemisphere. The morphological and phenomenological features of aurorae during the solar maximum (IGY) and minimum (IQSY) are compared. (auth)

46402 SPECTROSCOPIC MORPHOLOGY OF AURORA. Jones, A. Vallance (Univ. of Saskatchewan, Saskatoon). Ann. IQSY (Int. Years Quiet Sun), 4: 349-63(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The problem of determining spectroscopically the global excitation patterns of aurora excited by incident electrons and protons is reviewed. Previous studies contributing to the development of knowledge of the roles of these particles in auroral excitation are discussed. A description is given of a chain of spectroscopic stations operated in Canada during the IQSY for the purpose of defining more exactly the average and individual distribution of auroral protons. These stations covered the geomagnetic latitude range from about 58° to 77°N. Variations in the northern and southern limits of the hydrogen emission field with geomagnetic time for several individual nights are presented. Average positions of the southern limit as a function of geomagnetic time are given for $Kp \sim 0$ and for $Kp \geq 4$. In the former case the boundary is almost symmetrical about magnetic midnight when it lies at about 68° compared with about 71° at 1800 and 0600. In the latter case an equatorward "bulge" appears about 2100 when the average limit reaches 61° compared with 64° at 1800 and 63° at 0400. More accurate intensity contours are in preparation as well as studies of the hydrogen emissions in individual substorms. By comparing all the available data a mean hydrogen emission zone for $K_p \sim 2$ to 3 is suggested. (auth)

46403 NIGHT AIRGLOW OBSERVATIONS DURING THE IQSY. Roach, F. E.; Smith, L. L.; McKennan, J. R. (Environmental Science Services Administration, Boulder, Colo.). Ann. IQSY (Int. Years Quiet Sun), 4: 375-87(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

A preliminary analysis was made of airglow data accumulated from 17 stations as reported to the World Data Center A for the IQSY period (1964–1965). Special emphasis was placed on the zenith intensities and on the geographical gradient measured by the ratio of the extreme northern to the extreme southern regions of observation. (auth)

46404 AIRGLOW RESEARCH DURING AND SINCE THE IQSY. Weill, G. (Institut d'Astrophysique, Paris). Ann. IQSY (Int. Years Quiet Sun), 4: 388-99(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

Since the beginning of IQSY, world-wide morphology of the regular emission features of the night airglow has become better understood, although the station network is still defective. The information about the mesosphere contained in sodium D lines and the OH bands is not yet fully extracted. A number of distinct phenomena were identified, particularly in the F region, the recombination of which is observed optically. Airglow measurements from space have already met with limited success and appear to be promising in many respects. Spectral domains not observable from the ground, particularly in the far ultraviolet, should soon provide valuable information about the very high atmosphere. New or improved ground observation techniques now allow for fast kinetic temperature measurements of the main emissions, and for regular intensity monitoring of the weaker features in the spectrum. Airglow observations conducted in coordination with other atmospheric probing techniques are likely to yield many valuable results in the forthcoming decade. (auth)

46405 HYDROGEN AND HYDROXYL EMISSIONS IN THE NIGHTGLOW. Shefov, N. N.; Truttse, Yu. L. (Inst. of Physics of the Atmosphere, Moscow). Ann. IQSY (Int. Years Quiet Sun), 4: 400-6(1969).

From IQSY/COSPAR Symposium, London, England. See CONF-670729-(Vol.4).

The principal results of studies are briefly outlined. The intensity of the hydrogen Hα emission has regular annual, seasonal, and diurnal variations. The diurnal variations have in addition changes from night to night in the type of intensity variation in different directions of the sky. These data indicate apparently considerable dynamism in the atmospheric hydrogen component and also the possibility of additional excitation mechanisms for Hα emission. The intensity and rotational temperature of the hydroxyl emission show regular variations during the solar activity cycle, 1 year, 27 days, 29.5 days (lunar period), and night. Spatial variations of the hydroxyl emissions have also been studied. Regular and quite similar variations of the hydroxyl emissions are obtained during the appearance of noctilucent clouds and during periods of high meteoric activity. This indicates that injection of dust into the upper atmosphere considerably affects the rates of chemical processes at heights of about 100 km. (auth)

46406 SUDDEN ENHANCEMENT OF ATMOSPHERICS SUBSEQUENT TO NUCLEAR EXPLOSIONS IN THE ATMOSPHERE. Sen, A. (Univ. of Calcutta). Indian J. Pure Appl. Phys., 7: 434-8(June 1969).

Sudden enhancement of atmospherics (SEA) effects recorded on 30, 120, and 210 kc at Calcutta, subsequent to the megaton range nuclear explosions in the atmosphere made by the Russians in Novaya Zemlya late in 1961, have been critically examined. The SEA effect tends to be maximum around 120 kc, unlike the solar flare induced SEA, which shows a maximum around 27 kc. The probable mechanisms of the propagation of a lower ionospheric disturbance due to a nuclear explosion are discussed in relation to the observed delay time of an SEA after the detonation. (auth)

46407 DOPPLER OBSERVATIONS OF ASSOCIATED IONOSPHERIC AND MAGNETIC FLUCTUATIONS. Boyd, G. M.; Duffus, H. J. (Royal Roads Military Coll., Victoria, British Columbia). Can. J. Phys., 47: 1585-1600(Aug. 1, 1969).

Observations of ionospheric motions associated with magnetic micropulsations were conducted during a three-year period. Current theoretical models of the interaction indicate that observable Doppler shifts of high-frequency radio waves coherently reflected from the ionosphere should accompany all reasonably large geomagnetic disturbances, and vice versa, but this is not observed. Detailed studies of particular classes of events were therefore undertaken, involving spectral analyses, cross correlations, diurnal and seasonal occurrence statistics, and studies of associations with various types of ionospheric and magnetic records. Certain classes of magnetic pulsation events are found to be directly associated with F-region motions. Of the many possible mechanisms which may be responsible for these associations, two stand out as prime candidates: (i) hydromagnetic waves and (ii) neutral-gas waves modulating ionospheric electrojets. At mid-latitudes during quiet-sun years, the direct effects of precipitation of charged particles appear to be of much less importance. (auth)

46408 PHYSICAL MODEL OF A RADIO AURORA EVENT. McDiarmid, D. R.; McNamara, A. G. (National Research Council of Canada, Ottawa). Can. J. Phys., 47: 1271-81(June 15, 1969). (NRCC-10675).

A physical model is proposed to relate and explain the data obtained during a radio aurora event which occurred during the International Geophysical Year. One of Boström's electrojet models and the Farley two-stream instability form the basis of this model. The echoes obtained during the event were found to originate in the plasma bands associated with the visual forms and the orientation of the electric field was found to be east–west, which is in agreement with that predicted by the magnetospheric convection model of Brice. (auth)

46409 INFLUENCE OF CORPUSCULAR FLUXES IN THE MAGNETOSPHERE ON THE NIGHT IONOSPHERE. Velinov, P. (Bulgarian Academy of Sciences, Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 33-6(1969).

It is shown that fluxes of charged particles in the magnetosphere play an essential role in the ionization state of the low and medium night ionosphere, viz.: (a) corpuscular fluxes precipitating from the outside; (b) trapped particles; and (c) dumped particles of the Earth's radiation belts. (W.D.M.)

46410 COLLECTING A SAMPLE OF SOLAR WIND: AN EXPERIMENTAL STUDY OF ITS CAPTURE IN METAL FILMS. Lal, D. (Univ. of California, Los Angeles); Libby, W. F.; Wetherill, G.; Leventhal, J.; Alton, G. D. J. Appl. Phys., 40: 3257-67(July 1969).

Foils of Al, Mg, Mo, Pt, Au, and MYLAR were bombarded with known fluxes of ions (^{3}H, ^{4}He, ^{22}Ne, ^{37}Ar, ^{85}Kr), and accelerated to 1–40 keV in an electromagnetic isotope separator to determine the usefulness of a hypothetical experiment to bring home a sample of solar wind by exposing foils to the solar plasma current outside the Earth's geomagnetic cavity. The amounts retained in such foils after bombardment and after subjecting them to particular heating cycles in vacuum and in air (1 atm) were determined. The problems of the loss of ions in space during the proposed space experiment and of extraction of ions in the laboratory subsequent to recovery were thus studied. Aluminum seems to be an acceptable collector material for solar-wind ions. The trapping efficiency for other materials studied is variable and appreciably smaller than unity in some cases. However, since commercial aluminum can contain significant amounts of trapped rare gases, care must be taken to prepare the collector surfaces in their absence. (auth)

46411 GAS-SURFACE ENERGY TRANSFER EXPERIMENT FOR OGO-F. McKeown, Daniel; Dummer, Richard S. (Faraday Labs., La Jolla, Calif.). IEEE (Inst. Elec. Electron. Eng.), Trans. Geosci. Electron., GE-7: 98-106(Apr. 1969).

A gas-surface energy transfer experiment for the Orbiting Geophysical Observatory, Mission F (OGO-F), is described. The experiment will measure the kinetic energy flux of the upper atmosphere relative to the orbiting satellite, and the fraction of this energy that is transferred at normal incidence to surfaces. Four probes that can detect energy transfer between 10 $\mu W/cm^2$ and 0.1 W/cm^2 by the frequency change of temperature-sensitive oscillating quartz crystals are used to make the measurements. Probe accuracies of 3% and precision of measurements of better than 1% are maintained by periodic in-flight calibration of the crystal sensors. Data from the experiment will be used to determine the energy accommodation and drag coefficients of Al and Au, in O and N_2, the main components of the upper atmosphere between 400 and 1100 Km, and the planned altitude range of OGO-F. The kinetic energy flux measurement, besides being used in the determination of accommodation and drag coefficients, offers a novel method for determination of the upper atmospheric density and its scale height by relating measurements of the energy flux to the satellite ephemeris. (BBB)

46412 ORBITING GEOPHYSICAL OBSERVATORIES. Scull, Wilfred E. (Goddard Space Flight Center, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Eng.), Trans. Geosci. Electron., GE-7: 55-60(Apr. 1969).

A review is presented of studies being conducted by the Orbiting Geophysical Observatories (OGO), which are systems designed for making scientific and technological measurements within the earth's atmosphere, the magnetosphere, and cislunar space to obtain a better understanding of earth-sun relation and the earth as a planet. Planned to include observations through solar minimum and solar maximum, the OGO Program includes OGOs I-V and F to be launched ~9 months apart alternately into highly elliptical 31° orbits or low-altitude nearly circular polar orbits. Experiments being conducted in the OGO-I and OGO-III programs include those on solar cosmic rays, plasma by electrostatic analyzer and Faraday cup, positron search and γ-ray spectrum, trapped radiation by scintillation counter, cosmic-ray isotopic abundance, low-energy protons, cosmic-ray spectra and fluxes, trapped radiation and high-energy protons, low-energy electron and proton detectors, trapped radiation by electron spectrometer and ion chamber, triaxial search coil magnetometers, spherical ion and electron trap, planar ion and electron trap, radio propagation, atmospheric mass spectrum, interplanetary dust particles, vlf noise and propagation, radio astronomy, geocoronal Lyman-α scattering, and Gegenschein photometry. The experiments on OGO-II and OGO-IV programs additionally include whistler and audio frequency electromagnetic waves, low-energy proton-α measurements, airglow and auroral measurements, uv spectra of earth's atmosphere, neutral particles and ions, interplanetary and dust particles, ionospheric composition and solar uv flux, solar uv emissions, and solar x-ray emissions. Experiments being conducted in the OGO-V and OGO-F programs are also outlined. Of the 106 experiments orbited in the first 5 missions, only 1 experiment failed to operate after turn-on in orbit. The multi-appendaged structure, conservatively designed thermal control and power subsystems, and a data handling subsystem with capabilities of very high bit rates and extremely large storage capacities were combined in the OGOs to produce well-defined interfaces for which experiments can readily be designed, removed, modified, or reinstalled. Experimental data from the first 3 OGO missions are still being analyzed and correlated between the various experiments, and data from OGO-IV and V are in preliminary stages of analysis. Lists of all experiments and principal investigators for the 6 OGO missions are provided. (BBB)

46413 OGO SEARCH COIL MAGNETOMETER EXPERIMENTS. Frandsen, Allan M. A. (California Inst. of Tech., Pasadena); Holzer, Robert E.; Smith, Edward J. IEEE (Inst. Elec. Electron. Eng.), Trans. Geosci. Electron., GE-7: 61-74(Apr. 1969).

The Orbiting Geophysical Observatory (OGO) triaxial search coil magnetometer measures naturally occurring magnetic fluctuations between 0.01 and ~1000 Hz in the space around the earth. The instrument design is described and the design rationale discussed. The results of the observations on the first 5 OGO spacecraft in the magnetosphere, magnetotail, magnetosheath, and interplanetary medium, as well as at hydromagnetic bow shock, are summarized and discussed. Whistler waves within the magnetosphere appear to be intimately associated with the trapped particles in the Van Allen belts. Their power density, as well as their spatial and spectral distribution, are such that they may be produced by anisotropies in the particle distributions and may be responsible for precipitation of the particles from the trapping regions. Observations showed that the magnetotail is generally a very quiet region. The bursts of magnetic noise which do occur are found close to the neutral sheet. The magnetic noise may be indicative of a particle-accelerating mechanism in the neutral sheet but does not have the required power to produce particle acceleration itself. The bow shock has the most intense plasma waves of any part of the space around the earth. Oscillations of less than 1 Hz have amplitudes comparable to the dc field itself. The spectral power density in the shock is at least an order of magnitude greater than that in the magnetosheath. The spectrum of the waves at the bow shock is similar to spectra in the magnetosheath, and it is not clear how much of the magnetosheath spectrum is produced at the shock and propagated downstream and how much is due to the production of local instabilities in a marginally stable shocked plasma. The waves appearing upstream in the solar wind from the shock transition are largely in the whistler mode. They may be produced at the shock and propagate upstream or may be produced by particles accelerated at the shock which travel upstream. (BBB)

46414 AN EXPERIMENT TO STUDY ELECTRIC AND ELECTROMAGNETIC FIELDS IN THE FREQUENCY RANGE 10 Hz TO 540 KHz ON OGO-F. Carden, Robert C. (Time-Zero Corp., Torrance, Calif.); Laaspere, Thomas; Pratt, Blanchard. IEEE (Inst. Elec. Electron. Eng.), Trans. Geosci. Electron., GE-7: 78-88(Apr. 1969).

An experiment in the Orbiting Geophysical Observatory (OGO) series is described which will extend the frequency range over which whistler-mode waves have been observed in the ionosphere. The experiment uses an electric dipole antenna and will therefore also detect the essentially purely electric waves associated with the lower hybrid resonance noise bands. Emphasis is on broadband observations which are made in the bands 0.01 to 15, 15 to 30, 92.5 to 107.5, and 280 to 295 KHz. The experiment also includes 2 narrow-band receivers (at 200 and 540 KHz) and a subsystem to measure the antenna impedance at 4 frequencies (8, 24, 104.5, and 285 KHz). The design and the operation of the experiment are described, and its unusual features are emphasized and possible improvements pointed out. Discussion of the operation of the experiment is followed by a detailed discussion of each of the major subsystems. Mechanical design and the fabrication procedures of the experiment package are also considered. (BBB)

Low-Temperature Physics

Refer also to abstract 46567.

46415 (AD-685604) PHYSICS OF MANY PARTICLE SYSTEMS. Report for 1958–1968. Ambegaokar, Vinay; Wilkins, John W. (Cornell Univ., Ithaca, N. Y. Lab. of Atomic and Solid State Physics). Mar. 1969. Contract Nonr-401(38). 16p. (TR-31). CFSTI.

Research is reported in five main categories: Statistical mechanics and magnetism; Lattice vibrations; Energy conversion; Superconductivity; and, Many body effects in metals. The report summarizes the main trends of the research and the results that

have been achieved in each of these five areas. Published papers and Ph.D theses in each area are listed. (USGRDR)

46416 (IS-T-282) ANISOTROPY OF THE SUPERCONDUCTING ENERGY GAP IN THORIUM. Anderson, Joseph William (Ames Lab., Iowa). Nov. 1968. Contract W-7405-eng-82. 52p. Dep. CFSTI.

Thesis.

It was found that pure thorium has a mean-squared anisotropy in the energy gap of 0.021 and that it takes impurity scattering equivalent to a change in residual resistivity of approximately 6.0 $\mu\Omega$-cm to wash out this anisotropy. Decker's set of thorium–gadolinium samples all have residual resistivities of less than 0.861 $\mu\Omega$-cm, which is small compared to that required to wash out the energy gap. For a host material with $\langle a^2 \rangle = 0.021$ one would expect Decker's change in T_c due to anisotropy to be less than 0.03 K. This is only 4% of the total depression of T_c for his samples so it appears that magnetic scattering factors dominate. The same situation applies for the critical field measurements. The maximum change in the deviation function which could come from complete washing out of the anisotropy would be 0.007 and one would expect Decker's samples to show somewhat less change because anisotropy effects are only partially eliminated. For the thorium–0.2% gadolinium sample of Decker one might expect a change in D(t) (the deviation function) of 0.001 as estimated from Montgomery's measurement for a tin–indium system of comparable residual resistivity. This determination is used since the mean-squared anisotropy of tin (0.019) is rather close to that found here for thorium. The total change in D(t) as measured for Decker's thorium–0.2% gadolinium sample is 0.025 so again the magnetic scattering appears to completely dominate the situation. Hence the assumption by Decker that anisotropy effects were small for his samples is substantiated by this work. (auth)

46417 PERSISTENT METASTABLE STATES AND THE INHIBITED SCINTILLATION OF He II. Fischbach, Melvyn R.; Roberts, Huey A.; Hereford, Frank L. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett., 23: 462-4(Sept. 1, 1969).

The scintillation of liquid helium produced by α particles has been measured with particular emphasis on the temperature region below 1.25°K which had not been studied previously. An interpretation of the observed inhibition of the scintillation below T_λ is proposed which attributes the effect to a reduced radiative destruction rate of metastable states in He II. (auth)

46418 HEAT CAPACITY AT CONSTANT PRESSURE NEAR THE SUPERFLUID TRANSITION IN ^{4}He. Ahlers, Guenther (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev. Lett., 23: 464-8(Sept. 1, 1969).

High-precision data for C_p near T_λ are presented and three interpretations are given in terms of scaling predictions. No interpretation was found to be fully in agreement with the predicted symmetry of the transition and a divergent C_p. (auth)

46419 SIZE EFFECTS IN QUASIPARTICLE LIFETIMES AND PHONON GENERATION IN SUPERCONDUCTORS. Rothwarf, Allen (RCA Labs., Princeton, N. J.). Phys. Rev. Lett., 23: 468-70(Sept. 1, 1969).

In thin films and granular superconductors, the quantization of the phonon wave vector delimits the phonons which can be emitted in a recombination process. Jumps in lifetimes are predicted for injected quasi particles and the disappearance of some emitted phonons at characteristic values of Δ/kT. (auth)

46420 PHASE SEPARATION AND SUPERFLUID TRANSITION IN ^{3}He–^{4}He MIXTURES UNDER PRESSURE. Henriksen, Peter Nygaard. Athens, Ga., Univ. of Georgia, 1968. 309p.

Thesis.

The dielectric constant of ten liquid ^{3}He–^{4}He solutions has been measured between 0.5 and 1.4 K at pressures up to 20 atmospheres. The density was calculated from the dielectric constant using the Clausius–Mossotti relation and from the density versus temperature curves the lambda line and phase-separation curve were determined as functions of pressure for ^{3}He concentrations between 0.5 and 0.8. The temperature of the maximum of the phase-separation curve at 20 atmospheres was about 0.2 K lower than the corresponding temperature at saturated vapor pressure. It was found that the lambda line intersects the phase-separations curve at the maximum in the phase-separation curve. At the intersection of the lambda line and phase-separation curve the slope of the lambda line was coincident with the slope of the ^{3}He-rich branch of the phase-separation curve. The ^{4}He-rich branch of the phase-separation curve has zero slope for ^{3}He concentrations between 0.55 and 0.66 and at pressures greater than 0.23 atmospheres. At all pressures and concentrations above 54.9% ^{3}He an anomalous increase in density of approximately 0.04% was observed. For the 81% ^{3}He solution this anomaly occurred 0.19 K above phase-separation, and for the 59% ^{3}He solution, it immediately preceded the superfluid transition. (Diss. Abstr.)

46421 ac JOSEPHSON EFFECT IN SUPERFLUID HELIUM. Khorana, Brij Mohan. Cleveland, Case Western Reserve Univ., 1968. 55p.

Thesis.

Two superfluid helium baths were linked to each other through a small orifice. A quartz transducer produced a sound wave in the vicinity of the orifice, which served to couple the rate of vortex formation to the sound frequency. With the sound turned off, the gravitational flow through the orifice showed the weak dependence on the pressure head. When the sound was turned on after the level inside the beaker had reached equilibrium, the liquid began to be pumped out of the beaker and the arrest of the flow at certain liquid levels was observed. The spacing between most of the steps observed was found to be in integral multiples of the basic unit $z_0 = h\nu/mg$ (Josephson condition), although in a few instances it was $(n_2/n_1)\, z_0$. A model for the phase-slippage, due to the motion of quantized vortex rings, which can account for the observed effect is proposed. The stability of the liquid level at one of these "steps" appears to be indefinite—once arrested, the liquid remains arrested until disturbed by fluctuations. These observations provide convincing confirmation of the ac Josephson effect in liquid helium II. (Diss. Abstr.)

46422 SUPERCONDUCTING TRANSITION TEMPERATURES OF Nb-DOPED $SrTiO_3$. Pfeiffer, E. R.; Schooley, J. F. (National Bureau of Standards, Washington, D. C.). Phys. Lett., 29A: 589-90(Aug. 11, 1969).

Superconducting transitions in Nb-doped $SrTiO_3$ were observed over the range of charge-carrier densities $n = 0.13–2.2 \times 10^{20}$ cm^{-3}. A T_c maximum is observed similar to those previously observed in reduced $SrTiO_3$ specimens. (auth)

46423 THE ANISOTROPIC SUPERCONDUCTING ENERGY GAP OF Nb_3Sn. Hoffstein, V.; Cohen, R. W. (RCA Labs., Princeton, N. J.). Phys. Lett., 29A: 603-4(Aug. 11, 1969).

Tunneling measurements have been made on single crystal Nb_3Sn and have revealed a large anisotropy in the superconducting energy gap Δ with a very small average value. (auth)

46424 QUANTUM-INTERFERENCE PHENOMENA IN POINT CONTACTS BETWEEN TWO SUPERCONDUCTORS. De Waele, A. Th. A. M.; De Bruyn Ouboter, R. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 41: 225-54(Feb. 28, 1969).

A point contact, weakly connecting two superconductors, can be represented by an ideal Josephson junction ($i_s = i_1 \sin \varphi$) and an effective resistance ($R_n = V/i_n$; $V = -(\hbar/2)(\partial\varphi/\partial t)$) shunted in parallel to it. By solving the equation $i = i_1 + i_n = i_1 \sin \varphi(t) - (1/R_n)(\hbar/2e)(\partial\varphi(t)/\partial t)$ = constant, the dc current ($\bar{i}$), dc voltage ($\bar{V}$) characteristic for a single point contact is found to be $\bar{V}(t) = R_n\sqrt{(\bar{i}^2 - i_1^2)}$, independent of the magnetic field $B_\perp$. The relationship between dc current ($\bar{i}$), dc voltage ($\bar{V}$) and magnetic field ($B_\perp$) is also derived for a double junction, taking the self-inductance (L) of the area (O) embraced by the contacts into account. If $\pi Li_1 \ll h/2e$ then the self-induced flux is ignored and the current $i = 2i_1 \sin \varphi(t) \cos e/\hbar B_\perp O - (1/R_n)(\hbar/e2)(\partial\varphi/\partial t)$ = constant and $\bar{V}(t) = R_n\sqrt{(\bar{i}^2 - I_c^2(B_\perp))}$ for $i > i_c = 2i_1|\cos(e/\hbar) B_\perp O|$. This result explains the observed voltage oscillations in the resistive-superconductive region as a function of the external magnetic field $B_\perp$ when the applied current is constant and exceeds the critical value. If the self-induced flux is taken into account it is impossible to give a simple analytical solution and numerical methods are used. The total magnetic flux enclosed appears to be approximately quantized: $B_\perp O + Li_{circ} \approx n\, h/2e$, giving rise to a circulating current (i_{circ}) which adds to the applied current in one of the contacts and subtracts in the other. The modulation in the critical current is approximately given by $i_c \approx 2i_1 - (2/L)\,|n\, h/2e - B\, O|$, when $\pi Li_1 \gg h/2e$. The relationship between i, $\bar{V}$ and B is in agreement with experiment and can be represented by a corrugated surface periodic in $B_\perp$. (auth)

46425 DENSITY-MATRIX METHODS AND TIME DEPENDENCE OF ORDER PARAMETER IN SUPERCONDUCTORS. Di Castro, C. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Young, W. Nuovo Cim., 62B: 273-300 (Aug. 11, 1969).

The density-matrix equations for a superconductor are used to obtain corrections to the order parameter by means of a time-dependent perturbation technique. In particular, under certain restrictions a time-dependent differential equation for the order parameter in pure and dirty superconductors near the critical temperature is derived. Compared with the various equations obtained by the Green's function method, our equation is similar to those showing a diffusive character. Above T_c fluctuations of the order parameter relax according to the same equation. The density cannot be written in a simple differential form; however

an explicit expression for the time derivative of the density is given. From this we are able to show that within the scheme of the approximation used, the continuity equation is satisfied. The diffusion term, together with the derivative of the density with respect to time are shown to vanish whenever Josephson's equation is satisfied. Time-dependent perturbative solutions of the Hartree–Bogolyubov equations are given at any temperature and for any order in the pair potential. The first-order term is explicitly calculated. (auth)

46426 EFFECT OF DENSITY OF CONDUCTION ELECTRONS IN SUPERCONDUCTORS ON THEIR TRANSITION TEMPERATURE. Kessel, W. (Physikalisch-Technische Bundesanstalt, Brunswick). Z. Naturforsch., 24a: 294-5(Feb. 1969). (In German).

Morel calculated the phonon and Coulomb contributions to the mean interaction for a parabolic electron band as a function of the parameter $a^2 = (k_s/2k_F)^2$, where k_s is the square root of the reciprocal Thomas–Fermi shielding length and k_F is the radius of the Fermi sphere. The dependence of the coupling constant g as a function of a^2 was calculated for Sn, Tl, Pb, In, Zn, Cd, and Al. Also, dT_c/dn, where T_c is the transition temperature and n is the conduction electron density, was calculated for these simple conductors and compared with the measured values. (J.S.R.)

46427 ANISOTROPY OF THE SUPERCONDUCTING PROPERTIES OF NIOBIUM DISELENIDE AND THE RELATION BETWEEN THE PROPERTIES AND THE CRYSTAL STRUCTURE AND COMPOSITION. Antonova, E. A.; Medved'ev, S. A.; Shebalin, I. Yu. (Lebedev Inst. of Physics, Moscow). Zh. Eksp. Teor. Fiz., 57: 329-45(Aug. 1969). (In Russian).

The effect of anisotropy of the structure of a lamellar superconductor (niobium diselenide) on its superconducting properties is investigated. The magnetic properties and critical currents of niobium diselenide single crystals are studied in relation to the structure of the crystal lattice and its regulated disordering due to deviation from stoichiometry. Strong anisotropy of the magnetic properties as well as of the critical current, depending on direction of the magnetic field relative to the crystal plane is observed, and ascribed to anisotropy of the crystal structure of the compound. It is concluded that a most favorable direction for superconductivity that passes through the niobium planes exists in the given compound. From an investigation of the regulated disordering of the crystal lattice on magnetization and behavior of the critical current as a function of the magnitude and orientation of the magnetic field, it can be concluded that the state of the niobium sublattice viz., the degree of perfection of the niobium planes, decisively influences the superconducting properties of niobium diselenide. (auth)

46428 ABSORPTION AND DISPERSION OF SOUND IN A SUPERFLUID LIQUID NEAR THE λ POINT. Khalatnikov, I. M. (Inst. of Theoretical Physics, Moscow). Zh. Eksp. Teor. Fiz., 57: 489-97(Aug. 1969). (In Russian).

Absorption and dispersion of sound in a superfluid liquid near the λ point is investigated. A new deduction of the hydrodynamics equations for a superfluid liquid near the λ point is presented which contains some refinements with respect to the intial Pitaevskii deduction. The mechanism of sound attenuation consists in transfer of energy to second sound quanta with a wavelength of the order of the correlational length. Formulas are derived for dispersion of first sound velocity and for the second sound attenuation factor. (auth)

46429 NONLINEAR HIGH FREQUENCY PROPERTIES OF THIN SUPERCONDUCTING FILMS. Kulik, I. O. (Physical-Technical Inst., Kharkov). Zh. Eksp. Teor. Fiz., 57: 600-16 (Aug. 1969). (In Russian).

Nonlinear effects in thin-superconducting films at ultrahigh frequencies (uhf) are investigated, viz., the dependence of impedance on uhf field amplitude, decrease of critical superconducting current under the effect of uhf irradiation, harmonics generation, and mixing of frequencies in the presence of a stationary-current component. The critical power leading to the destruction of superconductivity is determined. It is shown that for films with a thickness $d \ll \delta_1$ (δ_1 is the London penetration depth) destruction of superconductivity is controlled by the electric component of a rapidly varying field. The critical field amplitude E_s is defined by the condition $eE_s\xi(T) \sim \hbar\omega$, where $\xi(T)$ is the temperature-dependent coherence length. The limits of stability of a homogeneous current state in the superconducting channel in the presence of a uhf field are found in the extreme cases of high and low frequencies ($\hbar\omega \gg (T_c - T)$ and $\hbar\omega \ll (T_c - T)$ respectively). The dependence of the film impedance on power is shown to be of a hysteresis nature. Thus, destruction of superconductivity by a uhf field occurs at a power that is much greater than that required for restoration of the superconducting state in a decreasing field. (auth)

46430 ON THE POSSIBILITY OF ROOM-TEMPERATURE SUPERCONDUCTIVITY IN DOUBLE-STRANDED DNA. Ladik, J.; Bierman, A. (City Coll., New York). Phys. Lett., 29A: 636-7(Aug. 11, 1969).

On the basis of Little's formalism, the possibility is outlined that at room temperature the virtual excitations of the π, of the σ and of the lone pair electrons in one chain of double-stranded DNA may cause a superconductive-type behavior of the delocalized π electrons in the other chain and vice versa. (auth)

46431 DAMPING AND RELAXATION PHENOMENA IN MULTIPLY CONNECTED SAMPLES OF SUPERCONDUCTORS OF THE SECOND KIND. van der Sluijs, J. C. A.; van Beelen, H.; Zweers, B. A.; Metselaar, J. W.; De Klerk, D. (Kamerlingh Onnes Laboratorium, Leiden). Physica, 41: 341-52(Feb. 28, 1969).

In a series of experiments on the resistive transition of Nb_3Sn ribbon and Nb–25% Zr wire in pulsed magnetic fields up to 330 kOe the deviation from the constant field behavior has been studied. A simple model was designed that explains the deviations as well as some results obtained by other investigators. (auth)

46432 SUPERCONDUCTIVITY IN SOME COMPOUNDS OF La, Lu, Sc, AND Y. Green, R. W.; Thorland, E. O.; Croat, J.; Legvold, S. (Ames Lab., Iowa). J. Appl. Phys., 40: 3161-2(July 1969).

A number of high-melting-point rare-earth compounds have been examined for superconductivity. In this work LaC_2, LuC_2, and YGa_2 were found to be superconductors, but Y_3C, $LaGa_2$, La_5Sn_3, and Y_5Sn_3 did not exhibit superconductivity in tests down to 1.4°K. (auth)

46433 ALLOY FERMI-SURFACE TOPOLOGY INFORMATION FROM SUPERCONDUCTIVITY MEASUREMENTS UNDER PRESSURE. Higgins, R. J.; Kaehn, H. D. (Univ. of Oregon, Eugene). Phys. Rev., 182: 649-57(June 15, 1969).

A modified BCS gap equation is used to obtain an approximate solution for the pressure derivative of the superconducting transition temperature, dT_c/dp, at values of the Fermi energy E_F near critical points in the density of states. dT_c/dp is a functional of the energy derivative of the density of states, and therefore reflects strong structure at values of E_F near the van Hove singularities in the density of states associated with a Fermi-surface topology change. The model is extended to include the case of a dilute random alloy system in which impurity scattering broadens the singularities. A Lorentzian spectral distribution is assumed, and an analytic equation is obtained for the broadened van Hove-singularity contributions to the density of states. The model is applied to the case of indium doped with cadmium, the rate of change of the Fermi energy with concentration being estimated from a free-electron formula, and the rate of change of the lifetime estimated from the residual resistivity. A qualitative fit between the model calculation and the structure of available dT_c/dp data requires the existence of two singularities: an electron saddle point disconnecting at 0.9 at.% Cd, and an electron sphere vanishing at about 1.6 at.% Cd. A quantitative calculation is made of the variation of dT_c/dp with alloy concentration, assuming only the empirically determined singular points, and deriving all other quantities from available indium Fermi-surface information on the third-band ring. The model calculation gives surprising quantitative agreement with the data, suggesting that valuable information on the Fermi-surface topology of dilute alloys can be obtained from measurements of dT_c/dp as a function of concentration. (auth)

46434 EFFICIENT USE OF STABILIZING MATERIALS IN SUPERCONDUCTING SOLENOIDS. Stevenson, Richard (McGill Univ. Magnet Lab., Longueuil, Quebec). Can. J. Phys., 47: 1401-7(July 1, 1969).

The problem of stability of superconducting solenoids is considered from a thermal point of view. The transient heat conduction equation for a superconducting tape clad with normal material and operated in a current sharing mode is studied, and a solution for the temperature distribution is obtained. The composite conductor is considered stable if its final temperature in the current-sharing mode corresponds to the critical temperature for the initial current density in the superconductor. Using this criterion, the operating point of the superconductor and its stabilizing cladding thickness can be chosen to give a maximum average current density in the composite conductor at any field. Calculations are given for Nb_3Sn tape clad with OFHC copper and with high-purity aluminum. (auth)

46435 CALCULATIONS OF THE EQUILIBRIUM CONFIGURATIONS OF FLUX LINES IN THIN FILMS OF TYPE-II SUPERCON-

DUCTORS. Carter, C. (Trent Univ., Peterborough, Ont.). Can. J. Phys., 47: 1447-60(July 15, 1969).

The London theory is used to calculate the equilibrium configurations of flux lines in thin films of a type-II superconductor as a function of the applied magnetic field. Three possible geometrical configurations, of increasing complexity, are considered in detail, and the Gibbs function is minimized with respect to the parameters which define the configuration. The range of applied magnetic field for which each configuration is stable is determined, and hence B–H curves are constructed. A transition from one configuration to another causes a discontinuity in the B–H curve at values of H which roughly correspond to those found experimentally by Sutton. (auth)

46436 SUPERCONDUCTIVITY AT HIGH PRESSURES. Brandt, N. B.; Ginzburg, N. I. (Moscow State Univ.). Usp. Fiz. Nauk, 98: 95-124(May 1969). (In Russian).

At present it is possible to obtain a pressure of 300 kbar at temperatures of 0.1°K. Construction details of equipment operating at high pressures at these low temperatures are reviewed critically. The superconducting transition temperature of all superconductors of the nontransition group is decreased with increasing pressure. New superconductors have been found by applying pressure to silicon, germanium, antimony, tellurium, and phosphorus. Thus, the number of superconducting elements in the Periodic Table has been expanded. Critical temperatures as a function of pressure are presented for the following elements: tin, indium, aluminum, cadmium, zinc, lead, niobium, vanadium, lanthanum, and uranium. The effect of impurities is discussed. With the use of high pressures, new superconducting modifications have been discovered in gallium, lanthanum, thallium, silicon, germanium, tin, bismuth, antimony, phosphorus, tellurium and selenium. This work is reviewed. The mechanism of the effect of pressure on superconductivity is discussed. 102 references. (TTT)

46437 STIMULATED EMISSION FROM NORMAL TO SUPERCONDUCTING METAL JUNCTIONS. Leopold, L.; Gregory, W. D.; Bostock, J. (Georgetown Univ., Washington, D. C.). Can. J. Phys., 47: 1167-70(June 1, 1969).

Stimulated radiative emission at the gap frequency in superconductors due to quasi-particle pairing is found to be more likely than stimulated phonon emission. Threshold conditions for lasing were calculated. The range of several parameters for which radiation may be expected is presented. (auth)

46438 OBSERVATION OF STIMULATED RADIATIVE EMISSION FROM NORMAL TO SUPERCONDUCTING METAL JUNCTIONS. Gregory, W. D.; Leopold, L.; Repici, D. (Georgetown Univ., Washington, D. C.). Can. J. Phys., 47: 1171-6(June 1, 1969).

Approximately 10^{-7} W of radiation at the energy-gap frequency of Ta (3 mm wavelength at 4.26°K) was observed traveling through free space from specially formed Ta–Al point contacts. This radiation appears discontinuously at a threshold current density of about 10^5 A/cm^2, disappears as the sample is warmed above T_c, and appears to be tunable by changing the energy gap with temperature. These results are consistent with predictions of stimulated emission from normal/superconductor contacts. (auth)

46439 THE EFFECT OF COOLING IN A MAGNETIC FIELD ON THE MAGNETIC HYSTERESIS OF NIOBIUM–TIN SUPERCONDUCTING ALLOYS. Potapov, N. N. Sb. Tr. Tsent. Nauch.-Issled. Inst. Chern. Met., No. 64, 99-103(1968). (In Russian).

Results are given of a study of the magnetic hysteresis of Nb–Sn alloys, containing 75 to 83 at.% Nb after cooling the specimens to 4.2°K both in the presence and absence of a magnetic field H_0. Hysteresis curves and curves of the density of stored magnetic energy are given. Plots were made of the dependence of quenched magnetic flux and density of maximum energy on H_0 and on the Nb content of the alloys. (Referativnyi Zh.) (Metals Abstr.)

46440 ELASTIC DEFORMATIONS IN SUPERCONDUCTORS. Kammerer, U. (Max-Planck-Institut fuer Metallforschung, Stuttgart. Univ., Stuttgart). Z. Phys., 227: 125-40(1969). (In German).

This paper starts from the original Ginzburg–Landau equations of superconductivity and the linear theory of elasticity for internal stresses as well as the experimental fact that the specific volume and the elastic constants vary throughout the superconducting phase. With the aid of phenomenological expressions for the free energy and the spontaneous deformation (superconductive magnetostriction) of a deformable type-II superconductor, a general method is given for the determination of the interaction between the field of the order parameter, the magnetic field, and the field of the elastic deformations. For an isolated straight vortex line and for a straight vortex line in the neighborhood of a dislocation of arbitrary character, formulas for the internal stresses are derived using first-order perturbation theory (corresponding to first powers in the changes of specific volume and elastic constants). (auth)

46441 INFLUENCE OF A STATIC MAGNETIC FIELD ON THE FLUCTUATION SUPERCONDUCTIVITY. Usadel, Klaus-Dieter (Univ., Goettingen, Ger.). Z. Phys., 227: 260-70 (1969).

The influence of an external static magnetic field on the additional conductivity due to fluctuation superconductivity for bulk material and for thin films is studied, with the magnetic field normal to the film surfaces. Only a weak-coupling superconductor in the dirty limit is considered. This additional conductivity turns out to be anisotropic in general. (auth)

46442 EQUATION OF STATE OF ^{4}He NEAR THE CRITICAL POINT. Mascheroni, Pedro Leonardo. Berkeley, Calif., Univ. of California, 1968. 142p.

Thesis.

The calculation of the equation of state of ^{4}He near the critical point is made using the theory developed by Riesenfeld and Watson. It is then found that by using a pseudopotential it is possible to solve the self-consistent equations in the effective mass approximation and in the first approximation of the nearest neighbor expansion. The computations show that the Van der Waals equation is an approximate solution of the problem with good semi-quantitative results for the critical point. (Diss. Abstr.)

46443 THERMAL CONDUCTIVITY OF LIQUID ^{4}He AND LIQUID ^{3}He. Kerrisk, Jerry Francis. Albuquerque, N. Mex., Univ. of New Mexico, 1968. 204p.

Thesis.

The thermal conductivity of liquid ^{4}He (helium I region) has been measured between 1.77°K and 3.95°K, and the thermal conductivity of liquid ^{3}He has been measured between 1.5°K and 3.95°K, both at pressures up to 34 atm. With ^{4}He, special attention was given to the vicinity of the λ-transition, where data were taken as close as 10^{-4} °K to the transition. With ^{3}He, the critical region was given special attention. Data were taken within 10^{-2} °K of the critical temperature. The thermal conductivity of ^{4}He and ^{3}He gas at low pressure has also been measured between 1.5°K and 3.95°K. Measurements were made using a steady state method with a fixed separation parallel plate apparatus. Heat was produced electrically in the upper plate and passed through the 0.0323 inch thick helium layer to the lower plate. The usual heater arrangement was avoided by providing an evacuated space around the upper plate and cell wall. The empty cell was calibrated to assess heat flow through paths other than the helium layer. Away from the λ-transition the thermal conductivity of liquid ^{4}He increases with increasing temperature and pressure, ranging from 1.4 to 2.9×10^{-4} watts/cm°K. As the λ-transition is approached (decreasing the temperature or the pressure) the thermal conductivity goes through a minimum, which is located approximately 2 to 4 atm (2 to 4×10^{-2} °K) away from the transition, and increases sharply. Values larger than 10×10^{-4} watts/cm°K were measured near the transition. Close to the transition the thermal conductivity is proportional to $(T - T_\lambda)^{-n}$, where n is approximately ½. Away from the critical point the thermal conductivity of liquid ^{3}He also increases with increasing temperature and pressure, ranging from 1.1 to 2.6×10^{-4} watts/cm °K. As the critical point (3.30°K, 1.15 atm) is approached the thermal conductivity increases. Measurements taken along isotherms above the critical temperature show maxima in the thermal conductivity occurring at pressures which parallel an extension of the vapor pressure curve. The peaks become sharper and higher as the isotherm temperature approaches the critical temperature. Values as large as 2.6×10^{-4} watts/cm°K were measured near the critical point. This is approximately a factor of two increase over the surrounding region. Experimental estimates of the contribution to heat transfer from convection near the ^{4}He λ-transition and the ^{3}He critical region indicated it was negligible. Any boundary resistance between helium and the cell plates was shown to affect the results by no more than 3%. A discussion of the general temperature and pressure variation of the thermal conductivity of liquid ^{4}He and ^{3}He, away from any transition, has been presented, based on a modified cell model calculation. (Diss. Abstr.)

46444 TRANSPORT EQUATIONS IN CLEAN SUPERCONDUCTORS. Betbeder-Matibet, O.; Nozieres, P. (l'Ecole Normale Superieure, Paris). Ann. Phys. (N. Y.), 51: 392-417(Feb. 15, 1969).

The situation considered is that of a clean uniform superconductor in thermal equilibrium, on which a small perturbation is

superimposed. The kinetic equation for the 2 × 2 matrix distribution function is established, including Fermi-liquid effects. In the macroscopic limit, when the wave vector and the frequency of the external field are much smaller than the inverse coherence length and the gap, the equation can be diagonalized: there remains a scalar equation for the distribution function of local quasiparticles. The sytem can be described by a two-fluid model (a superfluid and a normal fluid made of the local quasiparticles). The results of Stephen, and of Kemoklidze and Pitaevskii are here generalized to the case where Fermi-liquid effects are important. (auth)

46445 GINZBURG–LANDAU-FLUXOIDS. Kammerer, U. (Univ., Stuttgart). Comput. Phys. Commun., 1: 10-14(July 1969).

The Ginzburg–Landau-equations are solved for a straight single fluxoid containing an (integer) number q of flux quanta, starting from an approximate solution which has to be submitted by the user if q > 1. An iteration procedure is applied based on successive linearizations of the Ginzburg–Landau equations. In each iteration step, the system of linearized differential equations is solved by a finite-difference-technique with small intervals near the core and big intervals far outside. The line-energy of the fluxoid is calculated. (TSS)

46446 ON THE PAIRING THEORY OF THE BOSE SUPERFLUID. Evans, W. A. B.; Imry, Y. (Cornell Univ., Ithaca, N. Y.). Contract AT(30-1)-3326. Nuovo Cim., 63B: 155-84 (Sept. 11, 1969). (NYO–3326-24).

In analogy to the BCS theory of superconductivity, a self-consistent pairing theory of the Bose superfluid is developed along lines closely resembling the original Bose pairing model of Valatin and Butler. A new treatment of the zero-wave-vector terms is given which necessitates an attractive part to the interaction in order that a nontrivial solution for the (k-dependent) coherence parameter can exist. It is emphasized that the superfluid phase is best identified with a nonvanishing coherence parameter rather than with the presence of Bose–Einstein condensation, for, in systems with repulsive interactions, condensation can exist in this model without coherence. However, the coherent (superfluid) phase is shown to possess a macroscopic condensation which vanishes at the same temperature, T_λ, that marks the vanishing of coherence. The superfluid spectrum is manifestly gapless and initially linear. Numerical solutions to the self-consistent integral equations at T = 0 have been obtained for various pseudopotentials, some of which yield dispersion curves qualitatively resembling helium. The quasi-particle spectrum, condensed fraction, specific heat and sound velocity have been computed as functions of temperature for the complete range $0 \rightarrow T_\lambda$ for an attractive Gaussian pseudopotential while for some realistic pseudopotentials our numerical techniques were powerful enough only to yield solutions in a range near T = 0 not extending up to T_λ. The appropriateness of the model to account for the properties of superfluid helium is discussed and various extensions of our numerical work suggested. (auth)

Plasma and Thermonuclear Physics

46447 PLASMA PHYSICS INDEX. VOLUME 4, No. 7, 1969. Bibliography, Author Index, Subject Index. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 267p.

540 articles on various aspects of plasma physics are listed. (M.O.W.)

46448 ISSLEDOVANIE PLAZMENNYKH SGUSTKOV. VYPUSK 4. SBORNIKE POMESHCHENY DOKLADY SED'MOI KONFERENTSII PO FIZIKE PLAZMY FIZIKO-TEKHNICHESKOGO INSTITUTA AN USSR, SOSTOYAVSHCHEISYA 26 OKTYABRYA–14 NOYABRYA 1966 G. (Studies of Plasma Clusters. Volume 4. Seventh Conference on Plasma Physics at the Institute of Physics and Technology, Held at Kiev, October 26–November 14, 1966). Tolok, V. T. (ed.). Plasma Physics and Problems in Thermonuclear Synthesis Control. Kiev, Naukova Dumka, 1969. 136p. (CONF-661069).

The fifteen reports on plasma physics and thermonuclear synthesis are divided into two parts. The first part contains data on plasma accelerators considering plasma acceleration in the induction conical source, mass-spectrographic studies of plasma clusters generated by coaxial plasma guns, coaxial sources operating with mixed gases, and electromagnetic valves for pulsed gas induction. The second chapter includes eleven reports on plasma interactions with magnetic fields. The mechanism of moving plasma capture by transverse magnetic field, characteristics of plasma captured by transverse magnetic fields, and longitudinal polarization of plasma flux in transverse magnetic fields are discussed in the first three reports. Transverse injection of plasma into toroidal magnetic fields, plasma cluster interactions with axially symmetric magnetic fields of acute-angle geometries, and the motion and polarized interactions of plasma in multipole magnetic fields are analyzed in the following four reports. The last three reports examine the possibility of purifying hydrogen plasma clusters during its injection across an octopole magnetic field, plasma motion in crossed inhomogeneous electric and magnetic fields, and the use of alternating magnetic fields in order to obtain short clusters. (R.V.J.)

46449 PLASMA TECHNOLOGY. Gross, B.; Grycz, B.; Miklossy, K. New York, American Elsevier Publishing Company, Inc., 1969. 487p. $17.00.

Translated by Zdenek Rudinger.

The properties of materials at temperatures of several thousands or tens of thousands Centigrade at normal pressures are discussed. An introduction into the elucidation of these properties is given by methods of statistical physics and with help of kinetic theory. The basic methods for measuring plasma parameters, particularly spectroscopic methods, are described. The historical development of plasma torches is traced via various types of electric arcs and their efficiency is compared with more conventional methods of obtaining high temperatures. Design considerations and operating parameters for a family of plasma torches developed in Czechoslovakia are given in considerable detail, and these torches are compared with torches from U.S.A., U.S.S.R., West Germany, etc. The application of high-pressure plasma in engineering and in industrial research is discussed. The cutting of high-melting-point metals, coating by protective layers of refractory materials, melting, evaporation, thermal cracking of rocks, chemical reactions, and the testing of materials at high temperatures are also discussed. Particular attention is given to the problem of magnetohydrodynamic electric power generators. Applications in rocketry (plasma motors, simulation of reentry conditions etc.) are also cited. (TSS)

Confinement and Heating

46450 (CEA-CONF–1313) CONDITIONS FOR ELECTRON HEATING IN A BEAM PLASMA EXPERIMENT. Bottiglioni, Franco (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 4p. (CONF-690619–3). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

Experimental results dealing with the transition from the stable (first) to the unstable (second) regime in a beam–plasma system are presented. The electron heating occurs if the cold plasma density exceeds a critical value n_c, given by $0.5\ f_c \leq f_p \leq 0.7\ f_c$, in agreement with results reported earlier. Besides the excitation of strong oscillations, a trapping magnetic configuration seems to be necessary to heat the electrons. In a simple model of electron heating, presented here, the condition for electron trapping is given by a relation between the mirror ratio R and the amplitude of the fluctuating electric fields. (M.O.W.)

46451 (EUR-CEA-FC–470) REPORT OF ACTIVITIES OF THE RESEARCH GROUP FOR THE YEAR 1967. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 218p. (In French). Dep.

The experimental and theoretical studies on fusion devices made in 1967 are reported. The theoretical studies were centered on plasma configurations, stability, nonlinear effect and diffusion, and spectroscopy. The experimental studies can be divided into work on open configurations and closed machines. The three principal open machines are the M.M.I.I., DECA IIB, and bille-en-tete. The experimental results obtained with these machines are reported in some detail. The closed machines are the Harmonica and Stator. Experimental results are reported from these configurations. Experimental studies to expand these configurations are also reported. Experimental results are also reported from the study of waves in plasma and of the interaction of radiation with gas and solids. The characteristics of special ignitrons–superconductivity tubes–were determined. (J.S.R.)

46452 (EUR-CEA-FC–518) REPORT OF ACTIVITIES OF THE RESEARCH GROUP FOR THE PERIOD JANUARY 1, 1968–MARCH 31, 1969. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). 243p. Dep.

The theoretical and experimental studies on fusion devices made in 1967 are reported. The theoretical studies considered MHD confinement and stability, microinstabilities in waves, and study of the spectral rays emitted by plasma. The experimental

study on the accumulation and confinement of plasma was continued on open configurations, closed configurations, and formation of plasmas. The experimental results obtained from the bille-en-tete and Deca IIB are reported. The closed configuration machines Stator and Harmonica were both extensively modified during the year and the experimental results obtained with these modified instruments are reported. The properties of superconductivity devices used in the fusion devices are described. Studies made to improve the coordination and efficiency of studies in plasma physics are reported in some detail. These include studies of the interaction of radiation with matter, spectronomy of dense plasmas, nonlinear propagation and interaction of electromagnetic waves, plasma electron waves, waves and interactions of electron beams, derivative waves due to the pressure gradient, and fluctuations in plasma. (J.S.R.)

46453 SOME COMMENTS ON THE DIFFUSION OF PARTICLES IN STOCHASTIC RF FIELDS. Krlin, L. (Inst. of Plasma Physics, Prague). Czech. J. Phys., 19: 1076-91(1969).

The form of the distribution function $f(P_i,Q_i,t)$ is determined in terms of the integral W of the diffusion equation and of the initial distribution function $f_0(P_i,Q_i,t)$. W gives the probability of the occurence of a particle in the phase space P_i, Q_i. The Hamiltonian function of the particle and the distribution function f obtained in the above way are used for establishing the value of the absorbed energy and the rate of absorption in the case of the homogeneous magnetostatic fields. The conservative rf field-particle system (also in the nonlinear approximation), the effect of the nonlinearity of the diffusion tensor, and the meaning of the resonance for the rate of absorption are discussed. (auth)

46454 DEVICE FOR CONTAINING ELECTROMAGNETIC FLUID. Kawai, Tadashi (to Mitsubishi Electric Mfg. Co.). Japanese Patent 1969-14758. July 1, 1969. Filed Apr. 10, 1963.

The proposed electromagnetic fluid-containing device employs two magnetic fields rotating in opposite directions. It has the advantages of high containment efficiency, stabilized containment, and elimination of leakage from the cusp field. The device can be used in power generation by thermonuclear reactions, plasma light-sources, etc. The device includes a discharge tube containing gas and a set of electric conductors installed on the tube, which produce two linear cusp magnetic fields rotating in opposite directions. The device may include a discharge tube with gas, electric conductors on the tube for producing two linear cusp magnetic fields rotating in opposite directions, and a cylinder of a highly magnetic-permeable or electric-conducting material surrounding the conductors. The device may also include a discharge tube with gas, electric conductors on the tube for producing two linear cusp magnetic fields rotating in opposite directions, and coils on the tube for producing a dc magnetic field in the axial direction. (NSA of Japan)

Diagnostics

Refer also to abstracts 46338, 46339, and 46490.

46455 (NP-tr-1835) INVESTIGATION OF A MAGNETO-ACTIVE PLASMA BY FARADAY ROTATION. Dushin, L. A.; Pavlichenko, O. P. Translated for Culham Lab., Abingdon, Eng., from pp 77-81 of Issledovanie Plazmy s Pomoshch'yu Lazerov, Atomizdat, 1968. 6p. (CTO-630). Dep. CFSTI (U. S. Sales Only).

The experiment employing a laser to measure the Faraday rotation in a plasma is described. Oscillograms showing the signal and a diagram showing the results of an analysis of the oscillograms are discussed. (M.O.W.)

46456 (UCRL-50699) LASER LIGHT-SCATTERING MEASUREMENT OF PLASMA TEMPERATURE, DENSITY, AND CORRELATION SPECTRUM. Anderson, Oscar A. (California Univ., Livermore. Lawrence Radiation Lab.). July 7, 1969. 151p. Dep. CFSTI.

Thesis.

A physically oriented derivation of the differential cross section $\sigma(\underline{k},\omega)$ for light scattered by a quasi-stationary non-Maxwellian plasma is presented. It is found that, with mild restrictions on the distribution functions F_1 and F_e, the complicated result for $\sigma(\underline{k},\omega)$ may be simplified. Correlation lengths (generalizations of Debye lengths) are defined and used to divide the ω-spectrum into four ranges in which simple approximations for σ hold. A few constants depending on the shape of F_1 and F_e, then suffice to quantitatively describe all the important features of correlated scattering: ion-wave peaks, a nearby dip in the spectrum, a broad plateau, and plasma resonance peaks. The special case of deuterium plasma in thermal equilibrium is briefly treated. The experimental apparatus consisted of a plasma generator, a light source, a scattered-light analyzer, and an optical system for transferring light to the analyzer. The sheet-pinch plasma generator is discussed; it is shown to have particular advantages for studying correlated scattering. (M.O.W.)

46457 IMPEDANCE OF A PROBE IN A WARM PLASMA. Tunaley, J. K. E. (Sheffield Univ., Eng.); Grard, R. J. L. Ann. Geophys., 25: 55-65(Jan.-Mar. 1969).

When electrons pass in the vicinity of a probe, they interact with the electric field during their transit and, on the average, they remove energy from the system. Also the thermal movement of the electrons causes an electric dipole to radiate electro-acoustic waves. It is shown that the transit effect of the particles and the radiation of electro-acoustic waves are two different aspects of the same phenomenon. A straightforward approach to this problem is presented and the theory is applied to simple geometries. It is also shown how this treatment can be extended to the case of a magnetoplasma. (auth)

46458 DIAGNOSTIKA PLAZMY. SBORNIK STATEI. VYPUSK 2. (Plasma Diagnostics. Collection of Articles. Issue 2). Kukoleva, T. V. (ed.). Moscow, Atomizdat, 1968. 448p.

The development, analysis, and application of experimental methods for the investigation of plasma are considered. The following optical methods are discussed: optical interferometry of plasmas, applications of lasers and electron-optical transformers for spectral investigations of plasma, and vacuum ultraviolet, soft x-ray, and infrared techniques. Microwave methods for investigation of plasmas are also described. Other methods, including corpuscular, correlation, and bolometric techniques, are discussed. (tr-auth)

Kinetics (General)

46459 (AEC-tr-7079) ELECTROMAGNETIC PROPERTIES OF TURBULENT PLASMA. Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17705. 95p. Dep. CFSTI.

An abstract for the original Russian report appeared previously in NSA 23: 6989. (M.O.W.)

46460 (NP-tr-1836) TURBULENT PROCESSES IN A PLASMA SHOCKFRONT. Eskov, A. G.; Kurtmullaev, R. Kh.; Malyutin, A. I.; Pilskii, B. I.; Semenov, V. N. Translated from Zh. Eksp. Teor. Fiz., 56: 1480-9(1969). 18p. (CTO-628). Dep. CFSTI (U. S. Sales Only).

An abstract of this paper, prepared from the original language, appeared as NSA 23: 32367. (M.O.W.)

46461 MAGNETICALLY INDUCED CURRENTS AND THERMOELECTRIC EFFECTS IN A NONUNIFORM PLASMA STREAM. Dove, William Francis. Berkeley, Calif., Univ. of California, 1968. 187p.

Thesis.

Definition and effects of magnetically induced currents in a nonuniform, decaying, partially-ionized gas flow are reported. It is shown that it is possible to explain certain experimental observations if thermoelectric charge transport is included in the constitutive relation between fields and current density. In addition, (1) measured values of the ratio of an effective electron thermal conductivity to the thermoelectric coefficient and (2) experimental conditions suggest that this partially ionized-gas transport can be adequately explained in terms of the results of fully ionized-gas transport theory (Spitzer-Härm). Implicit in this result is the conclusion that the total emf induced in nonuniform ionized gases includes a direct contribution from the electron energy in addition to the well-known motional emf that derives from the relative motion of conductor and induction field. Since the Joule heating which results from the induced currents represents a perturbation to the argon afterglow, information concerning the net balance of recombination energy, radiation loss, and ion-electron energy transfer is available. Estimates of the magnitude of this balance in terms of a model based on three-body collisional-radiative decay [$e + e + A^+ \rightarrow e + A^*$] of the gas are presented. It is concluded that the gas is opaque to a substantial portion of the radiation. The analytical results presented herein derive from several convenient approximations which are permissible because of the experimental conditions. Among the approximations are the neglect of electron-neutral momentum-transfer collisions in nearly all of the plasma of interest. This implies the dominance of ion-electron momentum-transfer collisions, and electron-electron energy-transfer collisions. That, the strong collisional limit

($\Omega\tau \ll 1$), and the realization of frozen ionization mean that the observed effects originate in thermal processes, and require that the thermoelectric effect be included in Ohm's Law. Finally, the large values of the net balance of recombination energy, radiation, and energy transfer collisions allow the strong-recombination limit (namely, when electron temperature is dominated by the recombination process, $p \gg 1$) of the perturbed electron temperature to be obtained without restricting unduly the tractable magnitudes of the thermoelectric effects. Thus, it is necessary to include at least the perturbed thermoelectric effect in order to represent the data. This corresponds to the third power of the magnetic field strength if an expansion in a suitable small parameter is performed. (Disser. Abstr.)

46462 DETERMINATION OF TRANSPORT FUNCTIONS FROM THE CHARACTERISTICS OF CYLINDRICAL ARCS (HYDROGEN). Plantikow, U. (Technische Hochschule, Munich). Z. Phys., 227: 271-90(1969). (In German).

Measurements were performed on a stationary and symmetrical cylindrical arc produced in a cascade arc chamber in order to determine the transport coefficients of the H_2 plasma, especially the electrical conductivity σ and the heat flux potential S ($S = \int_0^T k\,dT'$; T = temperature, k = thermal conductivity). In a channel of 2 mm diam, and at a pressure of 1 atm, a wall load of 19 kW/cm^2 and an almost complete ionization were reached. The E–I characteristic was measured for H_2 in a wide range of arc currents. Because of technical and physical difficulties the total E–I characteristic had to be composed of measurements taken from three different channel diameters and converted by scaling laws to the smallest diameter. After this reduction an effective current range from 5×10^{-2} to 150 A is covered. For the measurement of the characteristics a quasi-static method was developed which is more precise than others used before. From the measured E–I characteristic, the radial distributions of the transport coefficients with the arc current I as parameter were computed exactly by means of the energy balance equation using a newly developed iteration procedure. The final result is the $\sigma(S)$ function of hydrogen. (auth)

Kinetics (Experimental)

46463 ANOMALOUS RESISTIVITY IN COLLISIONLESS PLASMA SHOCK WAVES. Krall, Nicholas A. (Univ. of Maryland, College Park); Book, David. Phys. Rev. Lett., 23: 574-6 (Sept. 15, 1969).

The anomalously large resistivity observed in collisionless shock-wave experiments is explained in terms of a drift instability of ion–acoustic waves. (auth)

46464 INVESTIGATION OF THE ION ENERGY DISTRIBUTION IN A STRONG COLLISION-FREE COMPRESSION WAVE. Schumacher, U. (Institut fuer Plasmaphysik, Garching, Ger.). Z. Phys., 227: 162-78(1969). (In German).

In a strong collision-free implosion wave generated by a fast theta pinch discharge, the density profile and the distribution of ion energies are investigated by spectroscopic methods. At low initial pressures (20 m torr D_2) an overturning of the ion sheath leads to an extended density profile and an effective thermalization of the ions in the plane perpendicular to the magnetic field with energies up to 500 eV, which are comparable with the energies of the directed ion motion. However, the thermal ion energies parallel to the direction of the magnetic field are lower by more than a factor of 2. This anisotropy may not be destroyed by ion two-stream instabilities, but possibly by anisotropy instabilities. (auth)

46465 PRELIMINARY INVESTIGATION OF ARC STABILIZATION WITH FORCED VORTEX. van Andel, H. W. H.; Hellingman, P. (EURATOM-FOM, Jutphaas, Netherlands). Z. Phys., 227: 195-206(1969).

The stabilization of an arc using a forced vortex was studied experimentally. Measurements on the arc characteristics were made as a function of the stabilizing flow parameters. It was found that the behavior of the arc may be understood in terms of measurements made on the stabilizing flow without the arc. It is concluded that stable arc operation may be achieved using forced vortex stabilization but, in open-ended systems, end effects on the vortex are likely to cause severe convective losses in the arc. (auth)

46466 EXPERIMENTAL MEASUREMENTS OF DISSOCIATIVE RECOMBINATION IN VIBRATIONALLY EXCITED GASES. Cunningham, A. J.; Hobson, R. M. (Queen's Univ., Belfast). Phys. Rev., 185: 98-100(Sept. 5, 1969).

Measurements of the temperature dependence of the dissociative recombination coefficients α in Ne_2^+ and Ar_2^+ are reported under conditions in which $T = T_i = T_e$. For both gases, the low-temperature variation of α was found to have an exponent of $-0.5^{+0.1}_{-0.1}$, while at high temperatures the exponent was -1.5 ± 0.1. The break between the high- and low-temperature dependencies, which occurred at 900°K for neon and at 670°K for argon, is seen to be a measure of the spacing between the ground and first vibrational levels in these molecular ions. (auth)

46467 ELECTRICAL CONDUCTIVITY OF AN OHMIC DISCHARGE PLASMA IN THE STELLARATOR "SIRIUS." Burchenko, P. Ya.; Vasilenko, B. T.; Volkov, E. D.; Potapenko, V. A.; Tolok, V. T. (At. Energ. (USSR), 27: 164-5(Aug. 1969). (In Russian).

A nonisothermal plasma with an electron temperature greater than the ion temperature is unstable in a strong electric field with respect to excitation to ion–acoustic and Langmuir oscillations. The results of a study of an anomaly in plasma resistance in above-critical electric fields have been qualitatively explained by excitation of these oscillations. Experiments were carried out in the stellarator "Sirius" under ohmic heating conditions with determination of the current in the plasma loop, the tension on the chamber bypass, the change in density with time, the diamagnetism of the plasma, x-ray and microwave emissions, and density distribution along the loop cross section. At high plasma concentration of $>5 \times 10^{13}$ cm^{-3} and electric field tension of 0.1 to 0.3 volts/cm the heating process is described by a classical collision mechanism. At lower concentrations of $<5 \times 10^{13}$ cm^{-3} the electron temperature becomes greater than the ion temperature, and microwave and x ray emissions appear. A rise in plasma resistance is noted. The resistance of the plasma loop is directly linked with the ratio of the applied electric field to the critical electric field. The difference in ion and electron temperatures varies substantially depending on the magnitude of the retaining magnetic field. (TTT)

46468 MECHANISM OF THE APPEARANCE OF ACCELERATED ELECTRONS ON INTERACTION OF AN ELECTRON BEAM WITH A PLASMA. Karkhov, A. N. At. Energ. (USSR), 26: 560-1(June 1969). (In Russian).

The experimental unit was a magnetic trap with an extended region of homogeneous magnetic field (about 300 cm). The 10-keV electron beam was injected at a current strength of 10 A over a period of about 500 μsec into a cold plasma. Vacuum conditions assured a low density of neutral gas with no noticeable, additional ionization on injection of the electron beam. The average plasma density along the cross section, and the x-ray emission were measured. The probe was oriented to measure the radial constituent of the electric field of the oscillations. Two maxima of x-ray emission are noted with change in plasma density. The plasma frequency, calculated from the average density, for these maxima coincided with harmonics of the cyclotron frequency. Circularly polarized electromagnetic waves interact with electrons which already have a large longitudinal velocity to give even more accelerated electrons. (TTT)

Kinetics (Theoretical)

Refer also to abstract 46292.

46469 (MATT-640) ELECTRON DISTRIBUTION FUNCTIONS IN WEAKLY IONIZED PLASMAS. Bernstein, Ira B. (Princeton Univ., N. J. Plasma Physics Lab.). Nov. 1968. Contract AT-(30-1)-1238. 53p. Dep. CFSTI.

The theory of the electron distribution function in a weakly ionized gas is developed by means of a perturbation expansion in powers of a small parameter which is essentially the sum of the fractional energy gain per electron per mean free time and the ratio of mean free path to macroscopic scale length. This permits not only a very rapid derivation of well-known results, but also the demonstration of various formal properties of the lowest significant-order equation. The boundary conditions on the leading term of the perturbation expansion are derived by means of a boundary-layer analysis from those on the unexpanded distribution function, in a simple situation. An extension of the method, which also incorporates the Chapman–Enskog method as a limit, is sketched. (auth)

46470 (NP-18007) ON THE POSSIBILITY OF AMPLIFYING ELECTROMAGNETIC EMISSION RELATED TO THE USE OF AVERAGED HIGH-FREQUENCY FIELD FORCES. Preprint No. 55. Luk'yanchikov, G. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). 1969. 6p. (In Russian). Dep. CFSTI (U. S. Sales Only).

An average force acts on a charge placed in a variable electric

field. It is shown that it is possible to have an increase in energy of the electromagnetic field with a charge moving through a high-frequency field. The particle in its oscillatory motion continually moves towards the electric field of the standing wave. An expression is given for the relative increase in power per unit length which is quite small. However, it is possible to increase the power by orders of magnitude by proper selection of the magnetic field and frequency. The method has advantages (no limitation due to space charge) in producing short-wavelength radiation. (TTT)

46471 (NP-tr-1837) QUASILINEAR RELAXATION OF AN ELECTRON BEAM IN AN INHOMOGENEOUS PLASMA. Ryutov, D. D. Translated for Culham Lab., Abingdon, Eng., from Zh. Eksp. Teor. Fiz., 57: 232-46(1969). 25p. (CTO-625). Dep. CFSTI (U. S. Sales Only).

The one-dimensional problem of the quasi-linear relaxation of an electron beam in a plasma with small density inhomogeneities, is investigated. It is shown that consideration of these effects leads to a significant change in the quasi-linear equation system. In particular, it is found that in the presence of small density inhomogeneities, quasi-linear relaxation leads to the appearance of electrons the velocity of which considerably exceeds the initial velocity of the beam. The part played by the usual density inhomogeneities in the problem of the stationary injection of a beam into a plasma half-space is also discussed. (auth)

46472 (ORO-3895-2) CURVILINEAR POLYADIC MOMENTS OF THE BOLTZMANN EQUATION. I. POLYADIC HIERARCHY FOR AN N-SPECIES, DILUTE, "POINT" PLASMA. Hawkins, Lawrence Carl (Miami Univ., Coral Gables, Fla. Dept. of Physics). [1969]. Contract AT(40-1)-3895. 34p. Dep. CFSTI.

The Maxwell transport equation is rederived, using a general curvilinear polyadic moment $\underset{\sim}{S}(\vec{r},\vec{v},t)$ of the Boltzmann equation. When this moment is specified in turn to be the velocity polyads $\underset{\sim}{S} = m, m\vec{v}, m\vec{v}\vec{v}, \ldots, m\vec{v}\vec{v}\ldots\vec{v}$, the coupled hierarchy of velocity moments for an N-species, dilute, point plasma is thereby obtained. For suitable choices of $\underset{\sim}{S}$ and proper polyadic contractions, all of the dilute, point plasma transport equations can be derived. Explicit results include: (1) The polyadic transport equation, with arbitrary acceleration $\vec{a}$, for the ℓ-th order polypressure $\underset{\sim}{\Gamma}_\ell = \rho\langle\vec{v}\vec{v}\vec{v}\ldots\vec{v}\rangle$ (ℓ terms). (2) The first seven moment transport equations, for both arbitrary acceleration $\vec{a}$ and electromagnetic acceleration $q(\vec{E} = \vec{v}\times\vec{B})$, governing the flow of mass density ρ, continuum velocity $\vec{V}$, energy density e, heat flux vector $\vec{q}$, pressure tensor $\underset{\sim}{P}$, heat flux tensor $\underset{\sim}{Q}$, and moment of momentum $\vec{r}\times m\vec{V}$. Included also is a brief outline of future papers in this series and an appendix summarizing the curvilinear polyadic calculus used throughout the series. (auth)

46473 (TID-25184) COMPUTER SIMULATION OF FLUID ION MOTION IN PLASMAS. Widner, Melvin Merle (Iowa Univ., Iowa City. Dept. of Electrical Engineering). Aug. 1969. 80p. Dep. CFSTI.

Thesis.

Several nonlinear plasma problems are solved by computer simulation with some experimental confirmation. All the problems involve plasma boundaries and events occurring on the time scale of the ion motion. The problems are: (1) ion sheath evolution and the accompanying ion-acoustic wave excitation, (2) interaction of an ion-acoustic wave with a steady-state ion space-charge sheath, and (3) plasma expansion into a vacuum. The computer simulation assumes a fluid model for cold ions and a thermal equilibrium model for hot background electrons. (auth)

46474 KINETIC THEORY OF FLUCTUATIONS IN TURBULENT PLASMAS. Ichimaru, Setsuo (Univ. of Illinois, Urbana). J. Phys. Soc. Jap., 26: Suppl., 76-7(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

A many-particle distribution function is constructed by summing all possible products of the single-particle distribution functions and the pair correlation functions. The BBGKY hierarchy of the plasma kinetic equations then exhibits a modification in the effective interaction between two particles owing to the presence of the finite correlations. The second member of the hierarchy is solved in the fluid limit for a uniform electron plasma assuming a weakly turbulent stationary state; a frequency and wave-vector-dependent dielectric response function $\epsilon(k,\omega)$ is obtained for such a turbulent plasma. The frequencies and the lifetimes of the collective mode are determined from the zeros of the response function. An integral equation for the energy spectrum ϵ_k is then obtained by equating these decay rates with the rates of the spontaneous emission of the density fluctuation excitations associated with the collective mode. (M.O.W.)

46475 CONDUCTIVITY OF A PLASMA WITH RANDOM AND COHERENT FLUCTUATIONS. Nishikawa, K. (Kyoto Univ.); Ichikawa, Y. J. Phys. Soc. Jap., 26: Suppl., 78-9(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

The effect of density fluctuations on the electrical conductivity of a fully ionized plasma in zero magnetic field is considered. Two cases are treated separately; one is the case in which the frequency Ω of the external electric field is large compared with the effective collision frequencies and the ion plasma frequency, and the other the case in which Ω equals zero. (M.O.W.)

46476 ELECTRICAL CONDUCTIVITY OF WEAKLY IONIZED GASES IN QUIESCENT AND TURBULENT STATES. Kihara, Taro; Totsuji, Hiroo (Tokyo Univ.). J. Phys. Soc. Jap., 26: Suppl., 80-1(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

The conductivity ratio σ_t/σ_q is calculated as a function of the electron temperature T_e. Here σ_t denotes the conductivity in the ideal turbulence, where the velocity distribution of the electrons is assumed to be a displaced Maxwellian distribution; σ_q denotes the conductivity in quiescence at the same electron temperature and the same degree of ionization. Results of the calculation are shown. (M.O.W.)

46477 QUANTUM NATURE OF THE FULLY IONIZED GAS. Grandy, W. T. Jr. (Univ. of Wyoming, Laramie). J. Phys. Soc. Jap., 26: Suppl., 82-3(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

The question of the existence of classical plasmas, independent of Planck's constant, is analyzed, leading to a definition of the classical limit. (M.O.W.)

46478 THEORY OF DISSOCIATIVE RECOMBINATION IN VIBRATIONALLY EXCITED GASES. O'Malley, Thomas F. (Queen's Univ., Belfast. General Research Corp., Santa Barbara, Calif.). Phys. Rev., 185: 101-4(Sept. 5, 1969).

For diatomic ions with large room-temperature recombination rates α, the simple temperature dependence $\alpha = CT_{el}^{-\frac{1}{2}}[1-\exp(-h\nu/kT_{ion})]$ is derived, which reproduces closely the precise experiments of Cunningham and Hobson, and others as well. The derivation uses the electronic threshold law plus a rapid falloff of the cross sections with vibrational state v. (auth)

46479 THERMODYNAMICS OF PARTIALLY IONIZED HYDROGEN. Samuilov, E. V. Dokl. Akad. Nauk SSSR, 186: 1059-62(June 11, 1969). (In Russian).

A system consisting of hydrogen atoms, protons, and electrons is assumed to be almost ideal with the interaction energy between the two charged particles having an exponential form. An expression is given for the statistical sum of a large canonical ensemble of protons and electrons. Sums describing the bound and free states of the proton and electron are given as average values. An expression is derived for the equilibrium constant of the concentrations of hydrogen atoms, protons, and electrons in a hydrogen plasma. All the thermodynamic functions can be calculated in an analogous fashion. (TTT)

46480 CONTRACTION OF CYLINDRICAL GAS DISCHARGE. Rakhimov, A. T.; Ulinich, F. R. (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 187: 72-4(July 1, 1969). (In Russian).

The contraction of a gas discharge along the volume of a tube was studied using equations of the electron energy balance and neutral gas $\sigma E^2 - \kappa(n_e T_e/\tau_e) = 0$ and $\kappa(n_e T_e/\tau_e) + (1/r)(\partial/\partial r)[r(n_0 T_0 \tau_0/M)(\partial T_0/\partial r)] = 0$, where $\kappa \approx m/M$, m is the electron mass, M is the neutral atom mass, τ_e is the time of elastic electron-neutral collisions, τ_0 is the time of elastic interatomic collisions; n_e, n_0, T_e, T_0 are density and temperature of plasma electrons and neutrals, respectively, and $\sigma = n_e e^2 \tau_e/m$ is the plasma conductivity. The contraction developed due to the conditions under which the gas temperature drops and gas density rises near the walls of the tube while the gas pressure along the tube is uniform. This condition causes the electrons to give out more energy to the neutrals, thus losing their temperature. The linear dependence of contraction radius on the radius of the tube at constant discharge current and at $x_R \lesssim 1$ (the case of weak contraction) was also studied. (R.V.J.)

46481 SIMPLIFIED APPROXIMATION FOR DETERMINING COEFFICIENT κ AND ELECTRON TEMPERATURE IN THE COLD ELECTRIC DISCHARGE ZONE. Rode, S. V.; Vasil'ev, S. S. (Moscow Technological Inst. of Light Industry). Zh. Fiz. Khim., 43: 2114-18(Aug. 1969). (In Russian).

The κ coefficient describes the fraction of electron gas energy lost by electrons during their collisions with molecules in elec-

tric discharge plasma. The calculations are in agreement with experimental data obtained from the two-probe method of measuring voltage equivalents ξ for electron temperatures. The data for $\varkappa$ was used for constructing a graph describing ξ as function of electric field gradient $E/_{p'}$ in the discharge zone. The graph exhibits the simple method of finding ξ by the known magnitudes $E/_{p'}$. (R.V.J.)

46482 LORENTZ-INVARIANCE OF THE DISTRIBUTION IN PHASE SPACE. Van Kampen, N. G. (Univ. of California, San Diego, La Jolla). Physica, 43: 244-62(July 8, 1969).

A proof is given of the Lorentz invariance of the distribution function f(r,p,t) in one-particle phase space. The proof is purely kinematical; no equations of motion are required. The result is used to show that particle density and particle current form a four vector, and that the energy density and momentum density are elements of an energy-stress tensor. Furthermore, the transformation of the momentum distribution is derived for free particles and for an ideal gas in equilibrium. In the latter case, the walls of the container play an essential role. Finally, the invariance is proved of a multiple-time version of the N-particle distribution function. (auth)

46483 CALCULATIONS OF STEADY MOTION OF CHARGED PARTICLE BEAMS IN EXTERNAL FIELDS. Volkov, B. I. Zh. Vychisl. Mat. I Mat. Fiz., 9: 961-7(July-Aug. 1969). (In Russian).

Calculations on electron devices and various type charged-particle injectors require determination of particle trajectories in electromagnetic fields, taking into account the influence of the space charge created by the particles themselves. An attempt was made at using a variation of the method of successive approximations for calculating a steady-state motion of charged-particle beams in an external field and, using a series of assumptions, convergence is shown. (R.V.J.)

46484 ANALOG DEVICE FOR DETERMINING THE VELOCITY DISTRIBUTION FUNCTION IN ELECTRON PLASMA. Stainov, G.; Nedyalkov, I. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 535-8(1969).

The examined dispersion equation is as follows: $-Ak^3 = w(z) = \int_{-\infty}^{+\infty} f'(u)du/z-u$, where $w(z) = u(x,y) + jv(x,y)$ is the analytical function of the complex variable $z = x + iy = \omega - jv/ks$, while v, s and A are constants. The main problem to be solved by means of the device is as follows: the values of the imaginary part of function $\omega(z)$ in fixed points z_i of the complex plane lying on a curve $L = L(z_i)$ are known; its values $v(x,0)$ on the real axis OX are sought. After solving this problem, the distribution function was found. (TSS)

Production

Refer also to abstract 45181.

46485 (AEC-tr-7056) SUPERHIGH-FREQUENCY GENERATION OF STRONGLY IONIZED ARGON PLASMA. Anisimov, A. I.; Vinogradov, N. I.; Golant, V. E.; Nanobashvili, S. I.; Pakhomov, L. P. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of report NP-17674. 8p. Dep. CFSTI.

An abstract for the original Russian report appeared in NSA 23: 3513. (M.O.W.)

46486 (CEA-CONF-1312) PRODUCTION OF ENERGETIC IONS IN A PENNING DISCHARGE. Fumelli, M.; Dei-Cas, R.; Girard, J. P.; Valckx, F. P. G. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 4p. (CONF-690619-5). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

A hot lithium plasma produced with a Penning discharge in a magnetic mirror geometry was investigated. Plasma properties during the discharge are described. (M.O.W.)

46487 (UCRL-50708) MEASUREMENT OF ENERGY DEPOSITION IN LASER-PRODUCED PLASMAS. Kachen, G. I.; Kysilka, J. O. (California Univ., Livermore. Lawrence Radiation Lab.). July 14, 1969. 6p. Dep. CFSTI.

Measurement of the energy absorbed in a laser-produced plasma is determined by two methods: (a) photodiode measurements of the intensity differential in the beam before and after breakdown and (b) pressure-transducer readings of the adiabatic pressure rise in the plasma enclosure. When corrections are made for the non-adiabatic losses, the two measuring techniques give equivalent results within experimental accuracy. (auth)

46488 IMPULSE PLASMA SOURCE OF THE INDUCTIVE-HYDRODYNAMIC TYPE. Jahn, G.; Rothhardt, L. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 11: 173-8(1969). (In German).

In order to avoid braking of the plasma by ionization and compression in an inductive hydrodynamic-type shock wave tube, the complete tube was evacuated to about 10^{-4} torr and the gas was introduced through a high-speed valve. The effect of the valve was shown by pictures of the luminescent phenomena in hydrogen and argon at pressures of 3 atm. The plasma velocity was determined for these gases as a function of the delay time in order to establish the optimum work region of the modified source. (J.S.R.)

46489 GLOW DISCHARGES IN HOMOGENEOUS AXIAL MAGNETIC FIELDS. Popow, G.; Rothhardt, L. (Institut fuer Magnetohydrodynamik, Jena, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 11: 182-7(1969). (In German).

Experiments on low-pressure cold-cathode discharges in argon at 0.1 to 1 torr are reported. The effect of an external axial magnetic field of 0 to 1500 G was studied, using probes and photoelectric collectors. It was shown that the plasma column of this discharge in the magnetic field is decomposed into two clearly different segments. The segment near the cathode can be interpreted as an expanding Faraday dark space with classical magnetic reduced diffusion. (tr-auth)

46490 THE LASER AND PLASMA PHYSICS. Bobin, J.-L. Nucleus (Paris), 10: 94-114(1969). (In French).

By concentrating laser emission, dense hot plasmas are produced, and by making use of it to illuminate an interferometer, diagnostic techniques are set up. The research described is pursued in three well-defined directions: to obtain hot plasmas; to know the basic mechanisms for the source of these plasmas; and to carry out precise measurements on laboratory plasmas. (tr-auth)

Stability

Refer also to abstracts 46451 and 46452.

46491 (CEA-CONF-1305) HIGH FREQUENCY ELECTROSTATIC INSTABILITIES IN AN INHOMOGENEOUS PLASMA. Girard, J. P.; Hennion, F. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 4p. (CONF-690619-7). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

The ion cyclotron drift instability with $k_{||} = 0$ is studied for the ease of different widths of the ion distribution function, magnetic curvature, and addition of cold plasma. It is shown numerically that this instability is sensitive to these three parameters. (M.O.W.)

46492 (CEA-CONF-1307) EFFECTS OF FINITE β ON THE STABILITY OF A CONFINED PLASMA. Rebut, P. H.; Samain, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1967]. 4p. (CONF-690619-9). Dep. CFSTI (U.S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

The stability of a confined plasma, where β is finite, ($\beta \leq 0, 1$), with gravitational forces and magnetic shear, is studied. Marginally unstable modes are studied also. (M.O.W.)

46493 (CEA-CONF-1308) NON LINEAR STABILITY OF A BEAM PLASMA SYSTEM. Samain, A. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1967]. 4p. (CONF-690619-10). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

The presence of unstable modes in a beam–plasma system is studied. It is assumed that all phenomena considered are periodic along the beam direction 0z with a definite period $2\pi/K_0$. It is also assumed that the marginally unstable mode is described by an electrostatic potential of the form $\exp(iK_0z + i\omega_{cr}t)$ and that the plasma instability is a reactive effect, not a resonant-particle effect. (M.O.W.)

46494 (CEA-CONF-1309) INSTABILITIES AND CYCLOTRON WAVE EXCITATION IN A HOT ELECTRON PLASMA. Jacquinot, J.; Kawasaki, S.; Leloup, C.; Poffe, J. P.; de Pretis, M.; Ripault, J.; Waelbroeck, F. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nu-

cleaires). [1968]. 4p. (CONF-690619-8). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

Measurements are reported on a velocity space instability, often observed in mirror-confined hot electron plasmas. The results are compared with theoretical expectation derived from linear electrostatic and electromagnetic theories. The amplification and damping of an externally induced cyclotron wave during its propagation along the axis of the hot electron plasma are studied. (M.O.W.)

46495 (LA-3844(Pt.2)) EQUILIBRIA OF COLLISIONLESS PLASMA. PART II. Morse, Richard L. (Los Alamos Scientific Lab., N. Mex.). Apr. 1969. Contract W-7405-eng-36. 13p. Dep. CFSTI.

Vlasov equilibrium methods are applied to straight z pinches and multipoles and then to toroidal equilibria. The last section contains a conjecture about the role of the rigid drift equilibria in real plasma containment experiments. (auth)

46496 (ORO-3895-1) AMBIPOLARITY AND PLASMA STABILITY. Robertson, Harry S. (Miami Univ., Coral Gables, Fla. Dept. of Physics). [1969]. 13p. Dep. CFSTI.

The following statement is offered as a conjecture: The steady state of a bounded plasma is that state for which $j \cdot dA = 0$ at every point of the boundary (except those that carry essential currents). A general theoretical argument in support of this conjecture (not a rigorous proof) is offered, based on the principle of minimum entropy production rate. Experimental evidence in support of the conjecture is cited. (auth)

46497 FEEDBACK CONTROL OF COLLISIONAL DRIFT WAVES BY MODULATED PARALLEL-ELECTRON-CURRENT SINK-EXPERIMENT AND INTERPRETATION. Simonen, T. C.; Chu, T. K.; Hendel, H. W. (Princeton Univ., N. J.). Phys. Rev. Lett., 23: 568-71(Sept. 15, 1969).

By modulating a parallel-electron-current sink, the collisional drift wave is stabilized with negative feedback in the unstable regime and destabilized with positive feedback in the stable regime. Upon stabilization, improved plasma confinement is measured. (auth)

46498 SMALL OSCILLATIONS IN DIFFUSION LAYER OF PLASMA IN THE PRESENCE OF A MAGNETIC FIELD. Vardanyan, V. A.; Oganesyan, R. S. (Erevan State Univ.). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 4: 65-70(1969). (In Russian).

The problem of stability of an ambipolar diffusion plasma layer with regard to small oscillations in the presence of a strong magnetic field is considered. No anomalous transverse effect of diffusion is observed in this case. For oscillations along and across the magnetic field the problem is solved accurately (linear approximation). (auth)

46499 HYDROMAGNETIC STABILITY OF A PLASMA IN A GRAVITATIONAL FIELD. Sersic, J. L. (Univ. Nacional de Cordoba, Argentina). Rev. Univ. Nac. Tucuman, Ser. A, 18: 153-64(1968).

The stability of a highly conducting fluid in an external magnetic field is studied. Special emphasis is given to the case in which the self-gravitation is negligible but the fluid is acted by forces deriving of a potential coming from a mass distribution independent of it. Under several assumptions, the stability depends critically of the elongation of the equilibrium and the concentration of mass that is the source of the gravitating forces. The figure of equilibrium of a highly conducting fluid mass in an external magnetic field uniform at large distances has been studied by several authors, both for the case of a sphere and a prolate ellipsoid. In the foregoing cases the fluid was considered self-gravitating, and it has been demonstrated that a whole sequence of prolate ellipsoids is an equilibrium sequence, but that the sphere does not belong to this sequence. Recently, D. G. Wentzel (1962) investigated the modes of hydromagnetic oscillations of a self-gravitating fluid with axisymmetric magnetic field inside and an originally spherically symmetric density distribution. In a sense, the present paper extends the Wentzel's results to the case of external magnetic and gravitational fields. (auth)

Thermonuclear Processes

46500 (AEC-tr-7067) ATTENUATOR BASED ON A FERRITE RESONANCE SWITCH. Tsopp, L. E. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17759. 8p. Dep. CFSTI.

An abstract for the original Russian report appeared in NSA 23: 12893. (M.O.W.)

46501 (CEA-CONF-1306) ASYMPTOTIC REPRESENTATION OF MAGNETIC FIELD LINES AND OF HYDROMAGNETIC EQUILIBRIA IN A NEIGHBORHOOD OF A CLOSED MAGNETIC LINE. Bineau, M. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1963]. 4p. (CONF-690619-2). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

An asymptotic definition is given to hydromagnetic equilibria in a neighborhood of a closed magnetic line $\mathcal{V}$ when the "rotation number" on $\mathcal{V}$ is irrational. This property generalizes a similar property of the trajectories of a Hamiltonian system related to the magnetic field. Asymptotic series (in powers of ρ = distance to $\mathcal{V}$) are first written for the components of the magnetic field before deriving an asymptotic representation of the trajectories. This analysis introduces the construction of an asymptotic system as an asymptotic definition of a hydromagnetic equilibrium. (auth)

46502 (CEA-CONF-1310) SINGULARITIES OF MAGNETIC FLUX IN "HARMONICA DEUX." Ginot, P.; Kuus, H.; Plinate, P. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 4p. (CONF-690619-6). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

"Harmonica Deux" is a torus in which the rotational transform is due to a longitudinal current induced into the gas, as in Tokamak. The longitudinal axis of the machine is planar with a variable curvature and has the shape of a guitar. A MHD theory from Mercier predicts singularities in the equilibrium for discrete values of the rotational transform linked to the variations of curvature of the axis. The experiment shows that singularities occur in the magnetic flux around the plasma for a given value of the rotational transform whose relationship with the theory is not clear. This phenomenon is discussed. (auth)

46503 (NP-tr-1825) MAGNETIC FIELD STRUCTURE IN THE L-1 STELLARATOR WITH $l = 2$. Lebedev Report No. 35. Komin, A. V.; Krasitskaya, L. V.; Minaev, V. M.; Kovrizhnykh, L. M.; Danilkin, I. S. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translated for Culham Lab., Abingdon, Eng., from report NP-17948. 14p. (CTO-621). Dep.

An abstract of this report, prepared from the original language, appeared as NSA 23: 36725. (M.O.W.)

46504 (UCRL-71740) MOLECULAR BAT. Batzer, T. H. (California Univ., Livermore. Lawrence Radiation Lab.). Aug. 5, 1969. 12p. (CONF-691006-1). Dep. CFSTI.

From 16th National Vacuum Symposium, Seattle, Wash.

One method used to produce and trap a hot hydrogen plasma for controlled thermonuclear research is to inject a beam of neutral hydrogen atoms, at 1 to 20 keV, into an ionizing and confining magnetic field. The production of such beams, accompanied by a minimum of contaminating thermal gas, presents some unusual pumping problems. The hydrogen ion source typically operates at a pressure of the 10^{-4} torr, the neutralizing gas cell at about 10^{-3} torr and, after about 10 to 15 ft of differential beam tube pumping, the plasma confinement chamber holds at 10^{-10} torr. The diffusing thermal gas as indicated by the gage readings can readily be pumped. However, traversing a gage across the confinement chamber indicates that a significant amount of streaming thermal gas enters the chamber from the source and neutralizers. To reduce the influx of gas to an acceptable level, a "Molecular Bat" has been devised to impart a transverse velocity to the streaming thermal gas without appreciably affecting the high-energy neutral beam. The Bat is comprised of a motor-driven spool aligned axially with the beam, on which thirty-six 0.001-in. aluminum vanes are mounted. The vanes sweep across the beam at a rotational speed of 10,000 rpm, imparting a transverse velocity to the streaming thermal gas. The design criteria are discussed and the device and its operation are described. (auth)

Wave Phenomena

Refer also to abstract 46345.

46505 (AEC-tr-7062) THEORY OF WAVES APPROACHING EXACT SOLUTIONS IN NONLINEAR ELECTRODYNAMICS AND OPTICS. Eleonskii, A. M.; Silin, V. P. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of Preprint No. 159. 35p. Dep. CFSTI.

The analysis carried out indicates that two-dimensional steady-state distributions of the field exist near the known one-dimensional

steady-state distributions of an electromagnetic field in a nonlinear medium with the two-dimensional distributions having a certain periodic structure when the amplitudes of the fundamental two-dimensional mode are small but finite. With respect to their character, the field distributions in question are analogous to the weakly nonlinear single-frequency steady-state eigenstates that appear under certain conditions in nonlinear oscillation systems with many degrees of freedom. In spite of the fact that the analysis of two-dimensional distributions of the field was carried out in this case for plane geometry, it may be stated that the basic conclusions regarding the character of two-dimensional distributions of a field in a nonlinear medium which approach the exact one-dimensional distributions will also be valid in the case of a more complex geometry of a field. (auth)

46506 (AEC-tr-7069) LINEAR WAVE TRANSFORMATION IN AN INHOMOGENEOUS MAGNETOACTIVE PLASMA. Piliya, A. D.; Fedorov, V. I. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of report FTI-144. 18p. Dep. CFSTI.

An abstract for the original Russian report appeared in NSA 23: 23191. (M.O.W.)

46507 (AEC-tr-7070) ABSORPTION OF ELECTROMAGNETIC WAVES IN A STRONGLY INHOMOGENEOUS PLASMA. Piliya, A. D.; Fedorov, V. I. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of report FTI-104. 14p. Dep. CFSTI.

An abstract for the original Russian report appeared in NSA 23: 23190. (M.O.W.)

46508 (CEA-CONF-1311) NONLINEAR BEHAVIOUR OF PLASMA UNDER THE INFLUENCE OF LARGE-AMPLITUDE WAVES. Fidone, I. (Commissariat a l'Energie Atomique, Fontenay-aux-Roses (France). Centre d'Etudes Nucleaires). [1968]. 15p. (CONF-690619-4). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Controlled Fusion and Plasma Physics, Utrecht, Netherlands.

Examples of wave–wave coupling in plasma are considered. Three typical situations are discussed, i.e., coupling between longitudinal waves, longitudinal–transverse, and transverse waves. The conditions for wave parametric amplification and wave conversion are found. (auth)

46509 (NP-tr-1678(Rev.)) KINETIC EQUATION FOR ELEMENTARY EXCITATIONS AND NONLINEAR INTERACTIONS BETWEEN WAVES IN A PLASMA. Tsytovich, V. N. (Akademiya Nauk SSSR, Moscow. Institut Fiziki). Translation of report NP-17575. 100p. (CTO-616). Dep. CFSTI (U. S. Sales Only).

An abstract of this Russian report, prepared from the original language, appeared as NSA 22: 44113.

46510 (ORO-3871-1) QUASISTATIC ION CYCLOTRON WAVE STUDIES. Progress Report. Swanson, D. G. (Texas Univ., Austin. Plasma Research Lab.). Aug. 15, 1969. Contract AT-(40-1)-3871. 20p. Dep. CFSTI.

At the present time, the experimental facility is virtually complete and in the testing stage. This has involved the complete redesign and construction of a new set of magnet coils for pulsed operation which allow adjustments in the field profile, and this phase has been completed and tested. In addition, it was determined a new form of ionization and preheater would be desirable, in the nature of a high-current axial discharge, and the redesign and construction has been completed and tested. Further studies of the plasma properties with the new ionizer are yet to be undertaken. The rf source and 80-kW pulsed oscillator-amplifier have been constructed and testing is presently underway. Although a few phases of the construction remain, such as a tuning box to match the transmitter into the launching antenna, it is anticipated that these things will be completed during the remainder of the contract year and studies of the wave properties in the high-density plasma can then be started. The principal theoretical effort has been the study of the group velocity of these waves. The matter of particular interest is the direction of propagation of these waves, since the waves by hypothesis have a phase angle which is nearly perpendicular to the magnetic field ($k_\perp \gg k_\parallel$). (auth)

46511 (ORO-3895-3) COMMENTS ON POYNTING'S THEOREM FOR A MOVING CONDUCTING MEDIUM. Hawkins, Lawrence Carl (Miami Univ., Coral Gables, Fla. Dept. of Physics). [1969]. Contract AT(40-1)-3895. 4p. Dep. CFSTI.

Two microscopic corrections to the transport equation of electromagnetic energy (Poynting's Theorem) in a moving conducting medium, derived in a recent communication, are found to be in error. (auth)

46512 (SU-IPR-311) ELECTRON CYCLOTRON ECHOES FROM PLASMA. Bruce, R. L. (Stanford Univ., Calif. Inst. for Plasma Research). May 1969. Contract AT(04-3)-326. 151p. Dep. CFSTI.

The response of a plasma column in a magnetic field to one, two, or three electromagnetic pulses under conditions where collective effects between the charged particles can be ignored, and a single-particle model is applicable is studied. The plasma response to a single pulse at the electron cyclotron frequency may be used as the basis of a diagnostic technique for obtaining collision data. The experimental method is described, and collision data obtained by this method are given for argon and neon. The effect of electron thermal motions on the accuracy of these results is considered, and the general limitations of the method are discussed. When the applied pulse frequency is far above the electron cyclotron frequency and plasma frequency, the plasma response may be used as a diagnostic for electron density. The method is described, and results are compared with data obtained by two other microwave techniques for electron density measurement. (M.O.W.)

46513 (SU-IPR-325) CYCLOTRON HARMONIC WAVE PROPAGATION AND INSTABILITIES. I. PERPENDICULAR PROPAGATION. Tataronis, J. A.; Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). June 1969. Contract AT(04-3)-326. 31p. Dep. CFSTI.

Computed dispersion characteristics are described for propagation perpendicular to the static magnetic field. For a ring electron velocity distribution it is found that mode coupling and absolute instability can occur. Similar effects are predicted for a spherical shell distribution. The Maxwellian distribution gives rise to stable propagation of undamped waves, and attenuating standing waves. A mixture of ring and Maxwellian distributions can give absolute instability with stronger growth and lower instability thresholds than for the ring distribution alone. (auth)

46514 (SU-IPR-326) CYCLOTRON HARMONIC WAVE PROPAGATION AND INSTABILITIES. II. OBLIQUE PROPAGATION. Tataronis, J. A.; Crawford, F. W. (Stanford Univ., Calif. Inst. for Plasma Research). June 1969. Contract AT(04-3)-326. 32p. Dep. CFSTI.

The ring and Maxwellian transverse velocity distributions, which are absolutely unstable and stable, respectively, for perpendicular propagation, are shown here to be both absolutely unstable for oblique propagation. Their instabilities are radically affected by the introduction of axial velocity spread. A detailed study is made for the cases of a Maxwellian transverse distribution with resonance and resonance-squared axial velocity distributions. It is shown that absolute instabilities occur at high energy anisotropies. These become convectively unstable as the anisotropy is reduced, and are quenched as isotropy is approached. The isotropic Maxwellian is treated in detail, and shows both cyclotron and Landau collisionless damping. (auth)

46515 APPEARANCE OF VARIOUS ION WAVE TYPES IN RARE GAS DISCHARGES AT LOW PRESSURES. Hinzpeter, G. (Institut fuer Gasentladungsphysik, Greifswald, Ger.). Monatsber. Deut. Akad. Wiss. Berlin, 11: 239-42(1969). (In German).

The various ion-type waves appearing in a discharge in neon in the range $10^{-3} < p < 1$ torr were investigated at currents up to 200 mA. With decreasing pressure to $\lesssim 10^{-2}$ torr, self-excited rapidly moving layers were observed whose plasma velocity sharply increased with simultaneous increase of the frequency and wave length. Under this pressure, another wave type occurs, whose propagation direction is opposite to that of the moving layers. The backward wave shows the dispersion behavior characteristic for these waves, but it can not be assigned to the known fast layer type. The forward wave corresponds in its dispersion behavior to an ion–acoustic wave. The frequency is almost completely pressure- and current-dependent. In the transition region, a second wave type was observed, which has a much lower velocity and occurs simultaneously with moving layers. The frequency of this ion–acoustic wave is between 30 and 70 kHz. (J.S.R.)

46516 FINITE AMPLITUDE ION–ACOUSTIC WAVES IN AN UNSTABLE PLASMA. Shut'ko, A. V. Zh. Eksp. Teor. Fiz., 57: 452-9(Aug. 1969). (In Russian).

An equation of the van der Pol type which describes a stationary, laminar ion–acoustic wave of finite amplitude propagating across a weak magnetic field is obtained on basis of the ion and electron hydrodynamic equations. For a sufficiently large ion viscosity the wave amplitude is proportional to the square root of the linear increment. For small ion viscosity a solution of the saw-like wave type exists, which describes the observed spikes in the ion–acoustic wave profile. It is also shown that waves of this type may also exist in a plasma with electrodes. (auth)

46517 FINITE AMPLITUDE WAVE BEAMS IN A MAGNETOACTIVE PLASMA. Litvak, A. G. (Gorky State Univ., USSR). Zh. Eksp. Teor. Fiz., 57: 629-36(Aug. 1969). (In Russian).

The self-action of electromagnetic wave beams in a magnetoactive plasma is investigated for the case of longitudinal propagation. A parabolic equation for the amplitude of the transverse component of the electric field of a broad (with respect to wavelength) wave beam is derived in the weak nonlinearity approximation. Mechanisms of nonlinearity in a magnetoactive plasma are considered, and expressions are derived for nonlinear corrections to the refractive index which are due to striction, heating, and nonlinearity of motion of a single electron. The necessary self-focusing condition for the case under consideration is obtained, and the characteristic self-focusing parameters are determined. Estimates are presented that point to the possibility of nonlinear self-consistent channeling of whistling atmospherics in the ionosphere and of decimeter electromagnetic waves in a laboratory plasma. (auth)

46518 HYDROMAGNETIC WAVES IN A FINITELY CONDUCTING FLUID MASS IMMERSED IN A NONUNIFORM MAGNETIC FIELD. Bajwa, G. S.; Srivastava, K. M. (Univ. of Jodhpur, India). Can. J. Phys., 47: 1011-16(May 1, 1969).

The propagation of hydromagnetic waves in a finitely conducting, nonviscous fluid mass of constant density was studied. It is immersed in a time-independent inhomogeneous magnetic field. Due to the nonuniformity of the magnetic field the lines of force are not in general straight lines, and use was made of a general curvilinear coordinate system. The lines of force of the magnetic field are taken as the coordinate lines and the propagation of hydromagnetic waves is explored. In the discussion, symmetry was chosen with respect to the binormal to the osculating plane containing lines of force, and the lines of force are assumed to be torsionless which make the curvilinear coordinate system orthogonal. By taking binormal as the z axis of the Cartesian coordinate system it is concluded that Alfvén waves propagate along the field lines and the local inhomogeneity of the magnetic field causes damping of the waves. (auth)

46519 THEORY OF DIFFRACTION OF ELECTROMAGNETIC WAVES IN ACTIVE MEDIA. Kalmykova, S. S.; Kurilko, V. I. Prikl. Mat. Mekh., 33: 638-47(1969). (In Russian).

The theory of diffraction in active media is applied in order to resolve the problem of congruence of plasma waveguides with electromagnetic waves amplified by a coaxial line of charged-particle beams. The coaxial line proved more effective than ordinary spiral energy, especially, in the case in which the phase velocities of the beam-excited waves were close to the velocities of light in the vacuum. An attempt is made at determining the field produced by scattering one of the amplified waves in the plasma waveguide. (R.V.J.)

46520 CYCLOTRON ECHO PHENOMENA. Gould, Roy W. (California Inst. of Tech., Pasadena). Amer. J. Phys., 37: 585-97(June 1969).

The physical mechanisms by which echoes are produced in a system of many charged particles gyrating in a static magnetic field is outlined. It is then shown how these ideas carry over to large systems of (almost) harmonic oscillators and are therefore applicable to many other physical systems. (auth)

46521 METHOD FOR SOLVING THE LINEARIZED DISPERSION EQUATION OF ELECTRON PLASMA. Stainov, G. (Inst. of Physics, Sofia). Compt. Rend. Acad. Bulg. Sci., 22: 531-3(1969).

The method aims at solving the linearized $-Ak^2 = W(z)$ for an infinite, homogeneous and isotropic electron plasma without external fields by the modelling of a harmonic function of the type $g(x,y) = \int V(x,y)dx$, where $V(x,y)$ is the imaginary part of function $W(z) = U(x,y) + jV(x,y)$ $\int_{-\infty}^{+\infty} f(u)du/z-u$. (TSS)

46522 PROPAGATION OF A PLANE ELECTROMAGNETIC WAVE ON TWO PARALLEL RADIALLY INHOMOGENEOUS ANISOTROPIC PLASMA CYLINDERS. Moshinskii, A. V. (Inst. of Radiotechnology, Minsk). Vestsi Akad. Navuk BSSR, Ser. Fiz.-Mat. Navuk, No. 4, 12-18(1969). (In Russian).

The summation theorem for cylindrical wave functions was used for resolving the problem of propagation of a plane TE wave in two anisotropic radially inhomogeneous plasma cylinders. The problem was resolved considering the effects of interactions of plasma cylinders. Circular cylindrical wave functions for unknown coefficients were derived, for which a system of linear equations was obtained, resolved by the reduction method. Expressions were found for the re-emitted field in the wave zone and for scattering radiolocation cross section. (tr-auth)

46523 DIFFUSIVE TRANSITION OF OSCILLATIONS IN UNBOUNDED LONGITUDINAL PLASMAS. Turski, A. J. (Monash Univ., Clayton, Victoria). Nuovo Cim., 63B: 115-30(Sept. 11, 1969).

The time-spatial-dependent electric-current density excited by the initial disturbance is expressed in terms of resolvent and forcing functions in the one-dimensional, isotropic, collisionless, nonrelativistic and linearized plasma. The resolvent kernel of Maxwellian plasma is interpreted as the dynamic current response to the step discontinuity of particle concentration, at the time t = 0 (shock-wave-type disturbance). Certain properties of plasma response are exhibited and the transition of oscillations in infinite plasma is related to diffusion processes. By use of the inverse Fourier transform in x of the Landau solution, the asymptotic expansion of the dynamic response is shown to be an oscillation decaying as $t^{-\frac{1}{2}}$. The implication of the continuous spectrum in k of Landau poles is outlined. (auth)

46524 RADIATION DAMPING OF RELATIVISTIC PLASMA OSCILLATIONS. Tam, Kwok-kee (Univ. of British Columbia, Vancouver); O'Hanlon, J.; Tam, K-kuen. Nuovo Cim., 63B: 241-9(Sept. 11, 1969).

Dispersion relations for linear, relativistic plasma oscillations including radiation reaction in the absence of external fields are derived. It is shown that the effect of radiation reaction, although negligible at low temperatures, becomes dominant in the region of extremely high effective temperatures. (auth)

Shielding

Refer also to abstracts 45439 and 46022.

46525 (ANS-SD-7) PROCEEDINGS OF THE SPECIAL SESSIONS ON GAMMA-RAY PRODUCTION AND TRANSPORT AND ON CIVIL DEFENSE SHIELDING. Presented at the 1967 Winter Meeting of the American Nuclear Society, Chicago, Illinois, November 1967. Straker, E. A. (ed.) (American Nuclear Society, Chicago, Ill.). Aug. 1969. 239p. (CONF-671140). Dep. CFSTI.

Papers are included on: state-of-the-art in thermal neutron capture gamma rays, the radiative capture of neutrons in and between resonances, the calculation of neutron capture gamma-ray spectra, the theory of gamma-ray cross sections, gamma-ray cross-section evaluation and compilation, the application of Spinney's method to secondary gamma-ray calculations, and some characteristics of secondary gamma-ray transport in asymmetric SNAP shields. Papers included on civil defense shielding are: some current problems in OCD fallout shielding calculations, radiation shielding studies at the Canadian Defense Research Board, the engineering method: problems of teaching and use in actual building design and analysis, neutron penetration in duct systems with large cross section, and shielding of ground based strategic weapons system against initial nuclear radiation. (M.H.R.)

46526 (CERN-69-17) LOSS OF PROTONS BY NUCLEAR INTERACTIONS IN VARIOUS MATERIALS. Measday, D. F.; Richard-Serre, C. (European Organization for Nuclear Research, Geneva (Switzerland)). June 25, 1969. 63p. Dep.

Tables are presented for the nuclear interactions of protons in various materials. The tables contain range-energy relations that were calculated using the latest nuclear reaction data. (J.W.R.)

46527 VOPROSY FIZIKI ZASHCHITY REAKTOROV. SBORNIK STATEI. VYPUSK 3. (Problems on Reactor Shielding Physics. Collection of Articles. Issue 3). Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. 248p.

Twenty three articles are included on the optimization of physical characteristics of shielding. Mathematical analysis was made on the space, energy and angular distributions of radiation in homogeneous and inhomogeneous shielding. Separate abstracts for each article were prepared. (240 references) (R.V.J.)

For abstracts of individual papers see: 46528–46545, 47331, and 47352–47355.

46528 CALCULATIONS OF OPTIMAL SHIELDING FOR A SOURCE PLACED NEAR THE EARTH SURFACE. Petrov, E. E. pp 24-33 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

An analytical solution is presented for the optimum type of shielding. This solution is calculated within classical variable approximations for portable surface installations. (R.V.J.)

46529 SOLUTION FOR THE TRANSPORT EQUATION BY MEAN FLUX METHOD. Germogenova, T. A.; Sushkevich, T. A. pp 34-46 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Various methods for resolving radiation transport equations are briefly reviewed. A nonlinear method for accelerating the process of convergence was used in order to resolve transport equations by the mean flux method. The method was effectively extended to problems of anisotropic indicatrices and multidimensional geometrics. (R.V.J.)

46530 SOLUTION FOR A ONE-VELOCITY PROBLEM ON NEUTRON SPACE DISTRIBUTION IN THE SPHERE WITH A CAVITY. Milyutina, Z. N.; Nikolaishvili, Sh. S. pp 47-53 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atmizdat, 1969. (In Russian).

An approximation method and tabulated data on neutron distribution inside a spherical layer are given for the case of a point isotropic source placed in the center of the sphere. (R.V.J.)

46531 SOLUTION FOR TRANSPORT EQUATION BY METHOD OF CHARACTERISTICS. Germogenova, T. A.; Bass, L. P. pp 69-77 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Transport equations were resolved by a method representing a median between the S_n method and the Vladimirov method (or, so called, a method of characteristics with interpolation). The method describes the angular behavior of neutron flux with higher precision than the results obtained by the S_n method. A problem on a point isotropic source in media with isotropic scattering was resolved by the suggested method. (R.V.J.)

46532 CORRELATION OF DIFFERENTIAL METHODS FOR RESOLVING TRANSPORT EQUATIONS. Nikolaishvili, Sh. S.; Mironovich, Yu. N. pp 78-88 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Correlations were made by differential methods for solution of one-dimensional transfer equations, considering the method of spherical harmonics, the S_n method, and the Vladimirov method. (R.V.J.)

46533 NUMERICAL METHOD FOR ASYMPTOTIC SOLUTION OF THE ONE-VELOCITY TRANSPORT EQUATION. Marchuk, G. I.; Nikolaishvili, Sh. S.; Mosolova, V. A. pp 89-96 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

An asymptotic solution for a one-velocity transport equation for infinite homogeneous media with anisotropic scattering is developed. The solution is efficient for numerical application, and is based on the Fourier–Laplace transforms. (R.V.J.)

46534 AZIMUTHAL FUNCTION OF ANGULAR DISTRIBUTION OF FAST NEUTRON BEHIND THIN IRON SHIELDING IN OBLIQUE RADIATION INCIDENCE. Goryachev, I. V.; Kukhtevich, V. I.; Polivanskii, V. P.; Suvorov, A. P.; Trykov, L. A. pp 97-115 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Experimental and theoretical data were obtained for angular and energy distributions of fast neutrons passing through iron shielding during normal and oblique incidence of a broad monodirectional neutron beam to the surface of a medium. The experimental data were correlated with results obtained by the $2P_1$ approximation utilizing the method of discrete ordinates modified by invariance principles. (R.V.J.)

46535 ANGULAR AND ENERGY DISTRIBUTION OF FAST NEUTRONS IN WATER, LITHIUM, AND TUNGSTEN HYDRIDES, AND BORON CARBIDE. Degtyarev, S. F.; Il'in, V. N.; Suvorov, A. P.; Tarasov, V. V.; Tikhonov, V. K.; Tsypin, S. G. pp 116-27 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Angular and energy distributions of <0.2-MeV fast neutrons behind water, lithium hydride, tungsten, and boron carbide were calculated. Experimental and theoretical data correlated for pure one-dimensional geometry were used for correcting the neutron group parameter system describing neutron diffusion in expanded systems. (R.V.J.)

46536 CONFIGURATION OF SCATTERED NEUTRON FIELD BEHIND POLYETHYLENE SHIELDING. Goryachev, I. V.; Kukhtevich, V. I.; Polivanskii, V. P.; Suvorov, A. P.; Trykov, L. A. pp 128-37 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Theoretical and experimental data on angular and energy distributions of fast neutrons behind 9.5- and 3.5-cm polyethylene shielding are presented. (R.V.J.)

46537 FIELD OF INTERMEDIATE ENERGY NEUTRONS IN CARBON. Bolyatko, V. V.; Lipunov, A. D.; Mashkovich, V. P.; Polivanskii, V. P.; Sinitsyn, B. I.; Suvorov, A. P.; Tsypin, S. G. pp 138-43 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Theoretical and experimental data on the angular, energy, and spatial distributions of intermediate-energy neutrons in extended 63-cm-thick carbon shielding are analyzed. (R.V.J.)

46538 ALBEDO OF NEUTRONS. Goryachev, I. V.; Kukhtevich, V. I.; Trykov, L. A. pp 144-52 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Angular and energy distributions of neutrons reflected from iron, ground, water, and polyethylene at normal and oblique incidence of a broad monodirectional neutron beam were calculated. Experimental, differential, and integral neutron albedo was studied as a function of the plane layer thickness of iron reflector. (R.V.J.)

46539 NEUTRON PENETRATION IN HYDROGEN CONTAINING MEDIA. Sinitsyn, B. I.; Tsypin, S. G. pp 153-60 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Semi-empirical methods were developed for calculating neutron penetration in media. Accuracy of the direct forward approximation used for calculating neutron penetration in hydrogen was analyzed. The method was expanded by using an energy function from derived cross sections for estimating fast neutron penetration in homogeneous hydrogenous media. (R.V.J.)

46540 RADIATION PENETRATION IN CYLINDRICAL CHANNELS IN SHIELDING. Goryanina, E. N.; Kozlovskii, S. A.; Kyz'yurov, V. S.; Popkov, K. K. pp 179-87 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

A radiation analysis method was used for obtaining formulas for calculating the γ-radiation flux along the axis of the straight and step-wise hollow cylindrical channels irradiated by surface and volume-absorbing sources. Also, distribution of fast neutrons along the axis of hollow and filled cylindrical channels was calculated. (R.V.J.)

46541 RADIATION RESISTANCE OF SHIELDING MATERIALS. Dubrovskii, V. B.; Ibragimov, Sh. Sh.; Krasnoyarov, N. V.; Kulakovskii, M. Ya.; Pergamenshchik, B. K.; Pinkhasik, M. S.; Savitskii, V. I. pp 188-97 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Radiation resistances of chromite concretes and iron oxides were analyzed. Thermal conductivity and the temperature coefficient of linear expansion of chromite concrete specimens irradiated with 2.4×10^{21} and 2.0×10^{21} n/cm^2 in the temperature range from 100 to 500°C are shown. (R.V.J.)

46542 SHIELDING PROPERTIES OF HEAT RESISTANT CONCRETES. Broder, D. L.; Dubrovskii, V. B.; Lavdanskii, P. A.; Pospelov, V. P.; Solov'ev, V. N. pp 198-207 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Shielding properties of heat-resistant chromite and magnesite concretes were examined for reactor neutrons and γ rays. It was found that even dehydrated heat-resistant chromite and magnesite concretes have good shielding properties in high-temperature conditions. (R.V.J.)

46543 NEUTRON PENETRATION THROUGH SHIELDING OF HEAT RESISTANT CHROMITE CONCRETE WITH BORON. Broder, D. L.; Dubrovskii, V. B.; Kulakovskii, M. Ya.; Lavdanskii, P. A.; Savitskii, V. I.; Solov'ev, V. N. pp 208-15 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

The radiation resistance of chromite concrete shielding was studied, and analyses were made of the influence of boron additions on the shielding properties and radiation emission. Data obtained showed that adding boron to heat-resistant concrete only slightly affected the buildup of intermediate-energy neutrons. Additions of 32 kg/m^3 boron and over did not improve the shielding properties. (R.V.J.)

46544 INFLUENCE OF BORON ADDITIONS ON SHIELDING PROPERTIES OF CONCRETES. Dubrovskii, V. B.; Kulakovskii, M. Ya.; Lavdanskii, P. A.; Savitskii, V. I.; Solov'ev, V. N. pp 216-27 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Shielding properties of chromite and magnesite concretes were studied, and the influence of boron additions on five types of shielding materials with 15, 30, and 60 kg/m^3 boron was analyzed. Tabulated and graphical data are given for various types of radiation, their doses behind the shielding, and the thickness of the shielding. It was revealed that small doses of boron did not influence fast neutron penetration but reduced significantly the passage of thermal neutrons. Increased concentration of boron in concretes from 15 to 60 kg/m^3 reduced the yield of capture γ rays about tenfold. (R.V.J.)

46545 INFLUENCE OF BORON ON HEAT-RELEASE IN CONCRETE SHIELDINGS. Dubrovskii, V. B.; Kulakovskii, M. Ya.; Lavdanskii, P. A.; Savitskii, V. I.; Solov'ev, V. N. pp 228-33 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Heat release resulting from capture γ radiation and α particles was calculated using five types of concretes with various boron concentrations. It was observed that boron additions to concretes of over 15 kg/m^3 did not reduce the integral heat release. Economic aspects of boron-containing and ordinary concrete shielding are discussed. (R.V.J.)

Solid-State Physics

Refer also to abstract 46415.

Radiation Effects

Refer also to abstract 45346.

46546 POINT-DEFECT ANNEALING IN γ-IRRADIATED LiF CRYSTALS. Andreev, G. A.; Vasil'ev, G. Ya. (Ioffe Inst. of Physics and Tech., Leningrad). Sov. Phys.-Solid State (Engl. Transl.), 11: 176-8(July 1969).

Translated from Fiz. Tverd. Tela, 11: 222-5(Jan. 1969).

Pure and Mg-doped (3.5×10^{-3}) LiF crystals were irradiated with 1×10^8, 2×10^8, and 3×10^8 gamma-ray doses, and their densities were measured after 15-min isochronous anneals. The results for pure crystals show maximum annealing of defects at ~250°C, with >95% of the defects disappearing above 450 to 500°C. Mg-doped crystals show a more complex annealing curve: the density increase proceeds in two stages; about half of the radioinduced change anneals out at 120 to 170°C, the density does not change at 170 to 260°C, and the remaining defects are annealed out at >270°C. The increase of density at >270°C is due to disintegration of the solid solution; its reconstitution at >300°C leads to decreased density. (D.L.C.)

46547 DIELECTRIC PHENOMENA AND ELECTRON SPIN RESONANCE IN NEUTRON-IRRADIATED QUARTZ. Kawai, Shichio (Osaka Univ.). Mem. Inst. Sci. Ind. Res. Osaka Univ., No. 26, 155-63(Feb. 1969).

The dielectric constant and loss factor of quartz, for both natural and synthetic specimens, irradiated by neutrons from a nuclear reactor were measured in the temperature range from room temperature up to about 450°C in the alternating electric field ranging between 0.3 kc to 1 Mc. The results are analyzed in terms of the Debye equation with a thermally activated relaxation time. Approximately linear relations between activation energies and the log of the total neutron doses were found. The activation energy is about 80 kcal/mole on neutron irradiation of 1.7×10^{18} nvt. There are two main groups of paramagnetic resonance: less intense and broad lines in the region of g values from 2.02 to 2.05 and moderately intense and narrow absorption lines in the region of g values from 2.00 to 2.01. The g values of the two line groups indicate that one center is an electron and the other a hole trapped in the lattice defects. Based on the lattice defects induced by elastic collision of neutrons, the probable molecular mechanisms responsible for these dielectric phenomena are presented. (NSA of Japan)

46548 RADIATION-INDUCED PARAMAGNETIC STATES OF SOME INTRINSIC DEFECTS IN ALKALI-GERMANATE GLASSES, POLYCRYSTALLINE GeO_2, AND SINGLE CRYSTALS OF GeO_2, TiO_2, AND SnO_2. Purcell, Terry Leonard. Knoxville, Tenn., Univ. of Tennessee, 1968. 131p.

Thesis.

Radioinduced paramagnetic states of some intrinsic defects in pure GeO_2 glasses, in GeO_2 glasses with added alkali oxide (M_2O/GeO_2 of 0.003, 0.03, and 0.3), and in crystals of GeO_2, TiO_2, and SnO_2 were investigated by electron spin resonance (ESR) techniques. The ESR measurements were made at 10 GHz and at 300, 77, or 4°K prior to warmup following electron, neutron, and γ irradiations at temperatures ranging from 77 to 350°K. The irradiated glasses displayed three distinct ESR spectra. The spectrum of γ-irradiated polycrystalline rutile GeO_2 was composed of a single resonance. After irradiation with neutrons, two additional signals were detected. The spectra observed in the glasses and polycrystalline rutile GeO_2 were simulated using a computer and assuming $S = \frac{1}{2}$ and $I = 0$. On the basis of the calculated g-values, spin concentrations, and oxidation–reduction treatments, five of the magnetic complexes were attributed to intrinsic defects. Models are: singly charged oxygen vacancies, Ge^{3+}, and O^- or O_2^- ions located at sites having different symmetries. Spectral data are presented for electron-irradiated hexagonal single crystals of GeO_2 at 140°K, neutron-irradiated as-received TiO_2 crystal at 140°K, previously γ-irradiated at a low temperature, a neutron-irradiated reduced TiO_2 at 140°K, and γ-irradiated reduced TiO_2 at 77°K. Good agreement between the observed orientation dependence and that calculated from a spin Hamiltonian with $S = \frac{1}{2}$ was found for each species. On the basis of concentrations, g-values, and hyperfine interactions, models for the resolved centers are proposed. These are: singly charged oxygen vacancies and Ti^{3+} at various interstitial and substitutional sites. Single crystals of SnO_2 exhibited resonances, which were attributed to impurities. No new spectral components were observed after electron irradiations at 77°K or neutron irradiations at 140°K. (Disser. Abstr.)

46549 COLOR CENTERS AND INTERSTITIALS IN X-IRRADIATED NaCl CRYSTALS. Van Nest, J. P.; Hutchison, T. S.; Rogers, D. H. (Royal Military Coll. of Canada, Kingston, Ont.). Can. J. Phys., 47: 1797-1803(Sept. 1, 1969).

Irradiation by x rays of NaCl crystals produces F centers and interstitial ions. The former are detected by measured changes in optical absorption, the latter by measured changes in the velocity of sound. A simple theory of dislocation pinning by interstitials accounts well for the changes in acoustic velocity. Current theories of initial-stage and final-stage coloration are justified by the results; estimates of the rates of defect production are made. (auth)

46550 HOW THE INTENSITY OF X RADIATION AFFECTS THE LATE-STAGE COLORATION IN VERY PURE KCl CRYSTALS. Jain, S. C.; Mehendru, P. C. (National Physical Lab., New Delhi). Nature (London), 223: 943(Aug. 30, 1969).

Reference is made to previous studies on how the intensity of an x-ray beam, E, affects a parameter a which defines the rate of generation of late stage anion vacancies in solids. Different authors have suggested different values for x in the relationship αE^x, depending on the value of E. The present authors describe a thermoluminescence study with very pure KCl crystals to determine the variation of x for low and high x-ray intensities. An x-ray diffraction unit operating at 35 kV and 5, 10, 15 and 20 mA was used for the irradiation, the intensity E being taken as proportional to the plate current of the x-ray tube. The rate of growth of the area under the 190°C thermoluminescence peak, corresponding to the bleaching of the second stage F centers, was studied in each case, and from the plots of this area against time of irradiation the values of a for each intensity of irradiation were determined. The results obtained were in agreement with a $\alpha E^{1.6}$ for lower intensities and a $\alpha E^{1.1}$ for the higher intensities. (UK)

46551 EFFECT OF IMPURITIES ON THE GAMMA-RAY COLORATION OF POTASSIUM CHLORIDE CRYSTALS. Hinks, David George. Corvallis, Oreg., Oregon State Univ., 1969. 114p.

Thesis.

The incorporation of Eu and Dy in KCl crystals was investigated. The crystals were prepared by the Kyropoulos method from melts containing the rare earth chlorides. The concentration of these rare earth ions in the crystals was determined by neutron-activation analysis. The distribution coefficient of Eu and Dy between the molten and solid KCl was found to be .21 and 1.3×10^{-4}, respectively. The molar absorptivity of Eu in the KCl crystals at two wavelengths, 241 and 325 mμ, was found to be 2880 and 2750 l/mole cm, respectively. The crystals doped with Dy did not exhibit any absorption bands. The effect of Eu, Dy, Pr, Ca, and Pb on the γ coloration of KCl crystals was studied. It was found that these five cations had the same qualitative effect on the coloration curve of pure KCl, although the magnitude of the effect depended on the specific impurity. At low impurity concentrations the total first-

stage coloration was not significantly changed, however, the rate of second-stage coloration was suppressed. As the impurity concentration was increased further, the coloration during the first stage increased and the second-stage coloration rate began to increase after reaching a minimum. The minimum in the rate of the second-stage coloration occurred at impurity concentrations below 1×10^{18} ions per cc. After the minimum in the second-stage rate of coloration was attained, the ratio of the total first-stage coloration to the second-stage rate of coloration was a constant that was independent of the impurity concentration. Solution-grown crystals exhibited lower first-stage coloration than melt-grown crystals, however, in the second stage the rate of coloration was larger for the solution-grown crystals. The second stage, which was linear for the melt-grown crystals, was generally not linear for the solution-grown crystals. The γ coloration of several nominally pure KCl crystals obtained from several different sources was investigated. From this study it was suggested that the colorability can be employed as a criterion of purity; the pure crystals will have a small first-stage coloration and a large second-stage rate of coloration. The ratio of the total first-stage coloration to the rate of second-stage coloration will become smaller as the purity increases. However, there are differences between the purity order established by the above criterion and conductivity data. (Diss. Abstr.)

Physical Properties

Refer also to abstracts 45263, 45270, 45271, 45278, 45279, 45595, 46001, and 46894–46896.

46552 (RLO-2012-3) SPECTROSCOPIC STUDIES OF ACTINIDE IONS IN CRYSTALLINE SOLIDS. Progress Report, October 1, 1968–September 30, 1969. Gruber, John B. (Washington State Univ., Pullman. Dept. of Physics). Contract AT(45-1)-2012. 203p. Dep. CFSTI.

Developments are reported for studies on: absorption spectra of Np^{4+} in single-crystal ThO_2; far ir studies of Np hexachloro compounds; ESR of Np^{4+} in ThO_2; NMR and NQR of actinide ions in single-crystal insulators; crystal spectrum of rare earth hexahalide complexes, MCl_6^{3-}, such as $(C_6H_5)_3PH_3NdCl_6$; double-photon excitation of rare earth and actinide ions in crystalline solids; electric conductivity of polar semiconductors via the Kubo formalism; absorption spectra of Tm^{3+} in $TmCl_3 \cdot 6H_2O$ and 2% Tm^{3+} in $YCl_3 \cdot 6H_2O$; absorption spectra of $Tm_2(SO_4)_3 \cdot 8H_2O$; construction of high temperature furnace and single-crystal growth preparation; and programs developed for solid-state physics. Two articles on double-photon excitation of rare earth and actinide ions in crystalline solids and galvanomagnetic properties of semiconductors are appended. (P.C.H.)

46553 (UUIP-620) X-RAY EMISSION SPECTRA OF VC_x, NbC_x, TaC_x, AND ZrC. Ramqvist, Lars; Ekstig, Boerje; Kaellne, Elisabeth; Noreland, Erik; Manne, Rolf (Uppsala Univ. (Sweden). Inst. of Physics). Feb. 1969. 23p. Dep. CFSTI (U.S. Sales Only).

X-ray emission spectra from VC_x, NbC_x, TaC_x and ZrC were measured with the corresponding spectra of the pure elements. Comparisons were also made with electron spectroscopy measurements, and with earlier reported metal and carbon soft x-ray spectra. In all the carbides investigated, the shift measurements and the metal band spectra confirm the positive character of the metal atom. (Sweden)

46554 MAGNETIC ANISOTROPY OF SOME HEAVY RARE-EARTH METALS. Du Plessis, P. de V. (Atomic Energy Board, Pretoria). Physica, 41: 379-88(Feb. 28, 1969).

The first-order axial anisotropy coefficient, K_2, was evaluated for terbium at constant magnetic fields from torque measurements in its paramagnetic region. In this region K_2 can also be calculated at constant magnetization from the known anisotropy in susceptibility between the basal plane and c axis. From the latter results, an extrapolation to 0°K was made on the basis of the validity of the single-ion theory for the anisotropy of the heavy rare earths. This yields the following values in erg/cm³ for $K_2(0)$: Tb, 2.7×10^8; Dy, 3.1×10^8; Ho, 1.0×10^8; Er, -1.9×10^8. The basal-plane anisotropy coefficient K_4^4 of terbium was determined at different temperatures and fields by direct torque measurements. It obeys the single-ion magnetization dependence with a value at 0°K of 2.9×10^6 erg/cm³. (auth)

46555 VOPROSY OBSHCHEI I PRIKLADNOI FIZIKI. Trudy Pernoi Respublikanskoi Konferentsii po Voprosam Obshchei i Prikladnoi Fiziki, 15–19 Maya 1967. (Problems of General and Applied Physics. Reports of the First Kazakh Republic Conference on General and Applied Physics, Alma-Ata, USSR, May 15–19, 1967). Alma-Ata, USSR, Izdatel'stvo Nauka Kazakhskoi SSR, 1969. 300p. (CONF-670556).

Ninety-eight reports are included on solid-state and semiconductor physics, optical and x-ray spectroscopy, luminescence, transfer phenomena, and radiation transport. Abnormal photoconductivity in fine films, electron structure in transition metals, radiation effects on properties of solids, gas dynamics, mathematical modeling are discussed. Separate abstracts were prepared for five articles of special interest. (R.V.J.)

For abstracts of individual papers see: 45515, 45564, 46070, 46071, and 46085.

46556 OPTICAL PROPERTIES AND BAND STRUCTURE OF VANADIUM DIOXIDE AND PENTOXIDE SINGLE CRYSTALS. Mokerov, V. G.; Rakov, A. V. Sov. Phys.-Solid State (Engl. Transl.), 11: 150-2(July 1969).

Translated from Fiz. Tverd. Tela, 11: 197-200(Jan. 1969).

Reflection spectra of VO_2 and V_2O_5 single crystals were measured in polarized light at 0.5 to 6.2 eV above and below the semiconductor–metal phase transition. The results show a strong anisotropy in the spectra of both oxides, the presence of a peak at 0.9 eV for VO_2, and interband electron transitions in VO_2 at $h\nu >$ 2 eV in both semiconductor and metallic phases. The band structure of the oxides is discussed. For V_2O_5, an insulator, the valence band is the 2p band of O and the conduction band is the 3d band of V. The reflection spectra of VO_2 is associated with an electron transition between the 2p band of O and the 3d band of V, with an energy gap of ≤2.9 eV. (D.L.C.)

46557 ELECTRICAL RESISTIVITY OF BINARY CHROMIUM ALLOYS WITH VANADIUM, NIOBIUM, AND TANTALUM. Arajs, Sigurds (Clarkson Coll. of Tech., Potsdam, N. Y.). Can. J. Phys., 47: 1005-10(May 1, 1969).

Electrical resistivity of binary chromium alloys containing 1.0_2, 2.0_4, and 3.0_8 at. % vanadium; 0.3_3, 0.5_7, and 1.1_3 at. % niobium; and 0.1_4, 0.3_9, and 0.5_8 at. % tantalum was measured as a function of temperature between 4 and 325°K. These studies show that the Néel temperature, T_N, decreases with increasing solute concentration in such a manner that in T plots are linear with respect to the solute content. The curve of T_N vs. solute concentration for tantalum, within the solubility limit, overlaps that for vanadium. The corresponding curve for niobium is slightly above the curve associated with vanadium and tantalum. This behavior cannot be explained simply from the viewpoint of the localization of d-wave functions using the model of Fedders and Martin. The increase in the residual electrical resistivity at 4.2°K due to 1 at. % vanadium, niobium, and tantalum was found to be 0.45, 2.7, and 3.6 μΩ cm, respectively. The residual resistivity vs. vanadium concentration curve shows an anomaly at about 3 at. % due to the changes in the Fermi surfaces, because of the disappearance of the antiferromagnetic state. None of the binary chromium alloys exhibit the Kim effect at low temperatures found in certain chromium alloys. (auth)

46558 NEW FORM OF La_2O_3. Felsche, J. (Eidgenoessische Technische Hochschule, Zurich). Naturwissenschaften, 56: 212(Apr. 1969).

The C-type structure of La_2O_3 was obtained during experiments on the synthesis of lanthanum orthosilicates. Properties of the structure are given. (W.D.M.)

46559 TEMPERATURE COEFFICIENT OF THE ELECTRIC RESISTANCE OF CARBIDES OF TITANIUM, ZIRCONIUM, AND NIOBIUM. Grebenkina, V. G.; Kuchma, A. Ya. Izv. Akad. Nauk SSSR, Neorg. Mater., 5: 717-20(Apr. 1969). (In Russian).

The temperature relation of the electric resistance was studied in the range from room temperatures to 1000°C for TiC, ZrC, and NbC in the homogeneous region. It was found that, with increased carbon lattice defects, the resistance of the carbide phases increased. (M.C.G.)

46560 THE USE OF NEUTRON ANOMALOUS SCATTERING IN CRYSTAL-STRUCTURE ANALYSIS. II. CENTROSYMMETRIC STRUCTURES. Singh, A. K.; Ramaseshan, S. (National Aeronautical Lab., Bangalore, India). Acta Crystallogr., Sect. B, 24: 1701-2(1968).

The methods for locating the positions of the anomalous scatterers in a centrosymmetric structure and determining the signs of the reflections using the data collected at two neutron energies are given. The results are general and can be used for x-ray anomalous scattering as well. (auth) (Denmark)

Moessbauer Effects and NMR

Refer also to abstracts 45592 and 47086.

46561 MOESSBAUER INDUCTION OF THE NUCLEAR INTERFERENCE OF γ RADIATION IN CRYSTALS. Belyakov, V. A.; Aivazyan, Yu. M. (All-Union Scientific Research Inst. of Physico-Technical and Radiotechnical Measurements, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 690-4(Apr. 1969). (In Russian).

Interference processes generated by resonance scattering of γ radiation on crystals, the energy of which coincides with the energy of the second excited level of the nuclei in the crystal lattice, were investigated. If a γ cascade from the second to the ground level may exist for these nuclei, then around the usual elastic scattering interference there will be a γ radiation interference, emitted during the transition from the second excited level. This interference results in a correlation between the direction of the emission of the γ quantum of the second level of the cascade and the direction of propagation of the two other γ quanta. The radiation widths of the first excited level depends on the direction of propagation of the first γ quantum and of the γ quantum of the first stage of the cascade. This was shown on several simplified models based on Moessbauer γ quanta; the results are considered valid for more realistic conditions. The derivations were examined specifically for ^{57}Fe, ^{161}Dy, and ^{186}W. (TTT)

46562 ANISOTROPY OF γ EMISSION OF ORIENTED NUCLEI IN MAGNETIC RESONANCE. Pokazan'ev, V. G. (Ural Polytechnic Inst., Sverdlovsk, USSR). Yadern. Fiz., 10: 70-3(July 1969). (In Russian).

The theory of γ emission by oriented nuclei affected by alternating magnetic field is given. It is shown that the effect of alternating fields is reduced not only to resonance dependence of γ-emission intensity on the field frequency but to the interference of magnetic sublevels of the excited state of the nucleus. The interference of nuclear states appears in pulses of intensity at the alternating-field frequency and multiple to it. Resonance dependence of constant and variable components of intensity can be used to detect magnetic resonance in excited states of nuclei. (auth)

46563 OBSERVATION OF INTERFERENCE OF CONVERSION AND OF THE PHOTOEFFECT ON ABSORPTION OF 26-keV GAMMA QUANTA BY Dy_2O_3. Borobchenko, D. V.; Lukashevich, I. I.; Sklyarevskii, V. V.; Filippov, N. I. JETP Lett. (USSR) (Engl. Transl.), 9: 139-42(Feb. 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 237-41(Feb. 20, 1969).

The interference between internal conversion and the photoeffect during gamma resonance absorption in powdered polycrystalline Dy_2O_3 enriched to 90% in ^{161}Dy was observed. The asymmetries in the Moessbauer spectra clearly indicate that there is interference between the two processes. (J.W.R.)

46564 DECELERATION OF SLOW RECOIL ATOMS IN SOLIDS. Akkerman, A. F. (Inst. of Nuclear Physics, Alma-Ata, USSR). Sov. Phys.-Solid State (Engl. Transl.), 11: 146-7 (July 1969).

Translated from Fiz. Tverd. Tela, 11: 193-5(Jan. 1969).

The resonance scattering cross section for γ rays is proportional to $P(E_r)$, the fraction of γ's whose energy is ± 1 eV of the resonance energy E_r. For the decay $^{63}Zn \rightarrow {}^{63}Cu$, where the maximum energy of the recoil atom is close to the minimum energy required to balance the energy loss during γ emission and absorption, $P(E_r)$ depends on the interaction of the recoil atom with its surroundings. Resonance excitation of the 0.668- and 0.961-MeV levels can be achieved in this way, and $P(E_r)$ is calculated for binary and multiparticle collisions. The multiparticle calculations are in good agreement with experiment for both γ transitions, indicating a multiparticle mechanism for the deceleration of slow recoil atoms. (D.L.C.)

46565 MODULATION EFFECTS AND THEIR APPLICATION IN HIGH RESOLUTION NUCLEAR RESONANCE SPECTROMETERS. Birkle, M.; Schulz, G. (Siemens Aktiengesellschaft, Karlsruhe, Ger.). J. Phys., E (London), 2: 846-50(Oct. 1969).

The solution of the Bloch differential equations is given for the case of sideband modulation. The discussion of the results indicates possibilities for control systems for the automatic balancing of the nuclear resonance spectrometer for detection of dispersion or absorption signals, with optimum adjustment of the high frequency part. Experimental realizations are reported and some spectra are presented to illustrate performance. The solution of the Bloch differential equations furthermore allows an assessment of the optimum modulation index and a calibration of the effective high frequency field. (auth) (UK)

Theory

Refer also to abstract 46639.

Theoretical Physics

Refer also to abstracts 46744, 46793, 46813, and 47249.

46566 (CNM-R-2(Vol. 3), pp 1237-47) CAN NEUTRON BEAMS SHOW DIFFRACTION IN TIME EFFECTS? Moshinsky, M. (Universidata Nacional Autonoma de Mexico, Mexico City. Instituto de Fisica. Comision Nacional de Energia Nuclear, Mexico City).

This paper is based on papers by the author (Phys. Rev., 82: 625(1952)) and Goldenberg and Nussenzweig (Rev. Mexicana Fiz., 6: 117(1957)). It is the opinion of the author that the phenomenon of diffraction in time is a simple quantum mechanical effect holding for beams of particles, which may already be within the reach of present experimental techniques for beams of neutrons; therefore, it is of interest to review this effect. (L.M.T.)

46567 METHOD OF A QUASI-LINEAR CANONICAL TRANSFORMATION FOR THE MANY-BODY PROBLEM. II. THE MANY-BOSON PROBLEM. Kanno, Shokichi (Osaka Univ.). Progr. Theor. Phys. (Kyoto), 41: 1145-76(May 1969).

The method of quasi-linear canonical transformation proposed in a previous paper is applied to the system of N interacting bosons, and the excitation energy for the dilute hard-sphere Bose gas is calculated. In the formulation the total number of the particles are exactly conserved in contrast with the Bogolyubov theory. There appears no logarithmic divergent term in the physical quantities which correspond to the self-energy operators Σ_{11} and Σ_{02} appearing in the method of Green's function. (auth)

46568 ON RADIATION OF A CHARGE MOVING ALONG THE CHANNEL AXIS IN A GYROTROPIC DIELECTRIC. Arakelyan, V. A.; Mergelyan, O. S. (Inst. of Radiophysics and Electronics, Erevan). Izv. Akad. Nauk Arm. SSR, Ser. Fiz., 4: 102-9(1969). (In Russian).

The radiation of a point charge moving along the channel axis in a gyrotropic dielectric medium is considered. Various particular cases are examined. The energy losses of the radiation are calculated and the polarization of the electromagnetic waves is studied. The anisotropy of the medium beyond the channel is shown to lead to various directions for phase velocity and for the beam. No Cherenkov beam is observed at the angle $\theta = \arccos 1/\beta n$. (auth)

46569 THEORY OF THE DISTRIBUTION FUNCTIONS FOR MANY-PARTICLE SYSTEMS. Isihara, A. (State Univ. of New York, Buffalo). J. Phys. Soc. Jap., 26: Suppl., 256-7(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

The grand distribution function of a many-body system was obtained by Gell-Mann and Brueckner (Phys. Rev., 106: 364(1957)) and later by Montroll and Ward (Phys. Fluids, 1: 55(1958)) and others in the ring diagram approximation. A corresponding formula for the pair distribution function $\rho 2(r)$ is reported here. (TSS)

46570 STATISTICAL MECHANICS OF QUANTUM MIXTURES. Ichimura, Hiroshi (Tokyo Inst. of Tech.). J. Phys. Soc. Jap., 26: Suppl., 258-60(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

It is shown that a slight modification of the well-known cluster expansion technique can yield an expansion formula for the partition function or the reduced density matrix of a mixture of quantum gases; which may be convenient even in highly degenerate cases. (TSS)

46571 DOUBLE DISPERSION RELATIONS IN QUANTUM STATISTICAL MECHANICS. Rajagopal, A. K. (Tata Inst. of Fundamental Research, Bombay); Cohen, Morrel H. J. Phys. Soc. Jap., 26: Suppl., 261-3(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

Much of the contemporary theory of many-body systems is expressed in the language of Green's functions, within which the one-particle Green's function G(12) plays a fundamental role. The equation of motion for G(12) does not close in the presence of interaction, and additional γ functions enter. It is found convenient to have a spectral representation for the γ functions, and this must take the form of a two-frequency, i.e., double dispersion relation. This double dispersion relation is developed here. (TSS)

46572 PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON STATISTICAL MECHANICS, KYOTO, SEPTEMBER 9–14, 1968. J. Phys. Soc. Jap., 26: Suppl., 1-321(1969). (CONF-680928).

Twelve papers were determined to be in scope, and individual abstracts are included for each. (L.M.T.)

For abstracts of individual papers see: 46161, 46474–46477, 46569–46571, 46895–46897, and 47061.

46573 RADIATIVE EMISSION AND THE FORCE OF RADIATION FRICTION DURING THE UNIFORM ACCELERATED MOTION OF A CHARGE. Ginzburg, V. L. (Lebedev Inst. of Physics, Moscow). Usp. Fiz. Nauk, 98: 569-85(July 1969). (In Russian).

From the work of Born 60 years ago it has been concluded that a uniformly accelerated charge does not radiate. Thus the force of radiation friction is equal to zero in this case, a conclusion which seems paradoxical in the presence of radiative emission. So the whole question is examined more closely. It is pointed out that, for the nonstationary case, the radiated energy and the work of the radiation force are not equal to each other. The behavior of a uniformly accelerated charge from the point of view of the equivalence principle is considered in detail. Apparent paradoxes are cleared up by calculating the emitted energy by means of different methods with conservation of energy being taken into account. It is necessary to study the radiative emission over a fixed period of time. However, under these conditions, since the acceleration of the charge is not always constant, the attracting field will not be constant with time, and this field will not be equivalent to the accelerated reference system. (TTT)

46574 ORIGIN SHIFTS IN DIVERGENT FEYNMAN INTEGRALS. Pugh, Robert E. (Univ. of Toronto). Can. J. Phys., 47: 1263-9(June 15, 1969).

The surface terms arising from a shift of origin in divergent Feynman integrals are considered. Sum rules and recursion relations between these terms are derived for an arbitrary degree of divergence and tensor rank. These relations are explicitly solved for linear, quadratic, cubic, and quartic divergences. (auth)

46575 INDISPENSABILITY OF NONLOCAL EXPRESSIONS FOR ENERGY- AND PARTICLE-DENSITY OF THE DIRAC-FIELD. I. Gerlach, Bernd (Univ., Marburg, Ger.). Z. Phys., 226: 446-53(1969). (In German).

Beginning with a short review of the familiar local theory of Dirac particles with arbitrary magnetic moments, it is shown that the usual expressions for energy- and particle-density are indefinite and unbounded below even in the one-particle subspace (Part I). An axiomatic derivation of definite densities leads necessarily to a nonlocal theory (Part II). (auth)

46576 CALCULATION OF THE LOWEST POLES OF TWO-POINT FUNCTIONS IN QUANTUM MECHANICS BY FUNCTIONAL INTEGRATION. Hoffmann, M. (Univ., Leipzig). Z. Naturforsch., 24a: 871-5(June 1969). (In German).

The lowest poles of the two-point function in quantum mechanics are calculated for some simple potentials by the method of functional integration, and the results are compared with the results of the usual methods. In most cases there is good agreement. The reasons for the disagreement in other cases are discussed. (auth)

46577 NEW FORMULATION OF STOCHASTIC THEORY AND QUANTUM MECHANICS. III. LAGRANGIAN FORMULATION AND ELECTROMAGNETIC COUPLING. de la Pena-Auerbach, L.; Getto, Ana M. (Univ. Nacional Autonoma de Mexico, Mexico City). Rev. Mex. Fis., 18: 253-64(1969).

The purpose of this note is threefold: (a) to show that, starting from a generalized D'Alembert principle, it is possible to express in Lagrangian form the basic equations of a stochastic theory recently proposed; (b) to obtain, using these generalized Lagrange equations, an expression for the electromagnetic force acting on a stochastic particle in an external electromagnetic field, in the nonrelativistic approximation—besides the Lorentz force, additional terms arise, which go to zero in the Newtonian limit; and (c) to show that, under the usual quantum-mechanical approximation, the substitution of this electromagnetic force in the fundamental stochastic equations leads to Schroedinger's equation with minimal electromagnetic coupling. (auth)

46578 A THOUGHT EXPERIMENT VIOLATING HEISENBERG'S UNCERTAINTY PRINCIPLE. Robinson, M. C. (McGill Univ., Montreal). Can. J. Phys., 47: 963-7(May 1, 1969).

In principle, it is possible to make simultaneous and precise measurements of a particle's velocity using two different methods, which should give identical results. It is shown that these results permit the calculation of the particle's position and momentum with a combined error $\Delta x \Delta p_x < \hbar/2$ at every instant of time in an arbitrarily large interval. It is also shown that, in the special case considered, the statistical interpretation of the wave function is invalid. (auth)

46579 NOTES ON THE RELATIONS BETWEEN THE ELECTROMAGNETIC FIELD QUANTITIES OF A MOVING MEDIUM. Sen Gupta, N. D. (Tata Inst. of Fundamental Research, Bombay). Rev. Roum. Phys., 14: 311-12(1969).

Recently, Gherman has derived two very interesting relations between the electromagnetic field quantities E, H, D and B, of a homogeneous material medium. Though they follow from the material equations of Minkowski, which are relations between the field quantities in a medium moving with uniform velocity with respect to an observer, they are independent of velocity. Hence, they exhibit a characteristic nature of the electrodynamic system in general. The object of this note is to derive a third relation, also independent of velocity, as a consequence of the Minkowski equations. (auth)

46580 QUANTUM THEORY OF SCATTERING FROM REAL MULTIPOLES. Burt, P. B.; Gettys, W. E.; Graben, H. W. (Clemson Univ., S. C.). Amer. J. Phys., 37: 840-1(Aug. 1969).

In the introductory discussions of scattering theory in quantum mechanics the examples chosen to illustrate the theory are usually one-center potentials. In this note, it is shown that the Born approximation for charged particles scattering from an array of point charges can be obtained simply and directly from the amplitude for Coulomb scattering from a single center. This can form a basis for a quantitative illustration of interference effects in scattering. (auth)

46581 QUANTUM MECHANICS. Rubinowicz, A. New York, American Elsevier Publishing Company, Inc., 1968. 591p. $15.00.

Translated by Eugene Lepa.

The following 11 chapters are included: (1) the old quantum theory, (2) matter waves and the Schroedinger wave equation, (3) mathematical apparatus of quantum mechanics, (4) simple problems of wave mechanics, (5) physical interpretation of quantum mechanics, (6) Pauli exclusion principle (7) approximate methods of solving eigenvalue problems, (8) theory of single scattering, (9) atoms and molecules, (10) the Dirac equation, and (11) quantization of an electromagnetic field, emission and absorption of light. (M.O.W.)

46582 A NOTE ON HARTREE–FOCK INSTABILITY. Nyberg, J. (Univ., Oslo). Nuovo Cim., Lett., 1: 687-8(May 11, 1969).

The simplest description of an infinite many-fermion system is obtained in the Hartree–Fock approximation, where one tries to find the Slater determinant which minimizes the expectation value of the Hamiltonian. If the particles of the system interact through short-range two-body forces, the "normal" solution corresponds to a Fermi sphere filled with plane-wave single-particle states. However, the problem of determining the solution which gives the absolute minimum of the expectation value is indeed difficult. A somewhat less-complicated problem is to find additional conditions that the normal Hartree–Fock solution must satisfy if it is the best solution. Such stability criteria may be derived by requiring that a slight deformation of the Hartree–Fock ground state, or of the Fermi surface, should not reduce the energy of the system. A further necessary condition for stability, which is discussed, is that the self-consistent energies of the occupied levels should be less than the self-consistent energies of the unoccupied levels. (TSS)

46583 STATISTICAL BASIS OF PHYSICAL LAWS. Collins, R. E. (Univ. of Houston, Tex.). Phys. Rev., 183: 1081-97 (July 25, 1969).

The premise that physical variables must be viewed as random variables, with observed values, assigned as averages over distributions, is shown to yield the formalisms of thermodynamics, Hamiltonian mechanics, and quantum theory. A general mathematical argument first establishes the validity of an embedding of the space of physical variables in a larger manifold of "hidden" variables and a general structure for the distribution of these variables. Then, by consideration of various ways of specifying the preparation of a system for measurement, the formalisms of physics cited above are deduced. It is also shown that the generalized Langevin equation follows from these premises and is applicable to a wide class of phenomena. This formulation yields a new definition for compatible observables as used in quantum theory and demonstrates, in a natural way, that physical laws should be invariant under orthogonal transformations of certain variables, which in one circumstance include the complex orthogonal transformations of the Lorentz form, as in special relativity. In summary, it appears that most of the formal structure of physical theory is a consequence of the statistical nature of physical variables. (auth)

46584 SIMULTANEOUS MEASUREMENT IN THE BOHM–BUB HIDDEN-VARIABLE THEORY. Tutsch, J. H. (Univ. of Wisconsin, Janesville). Phys. Rev., 183: 1116-31(July 25, 1969).

A recently proposed theory of measurement for nonrelativistic quantum mechanics, due to Bohm and Bub, is generalized, and a mathematical analysis of the theory is presented. The fact that there are always theories of the Bohm-Bub type, given the standard formulation of quantum mechanics, is discussed. The phenomenological coefficient γ of the original theory is defined to be the absolute value of the energy change of the system during measurement divided by $\hbar$. This definition leads to a Heisenberg-like relation between the average energy change of the system during the measurement process and the collapse time, but the new relation depends on the so-called hidden variables, and hence could lead to non-quantum-mechanical effects. The time dependence of the hidden variables is considered, and they are then assumed to be constant for each individual system. An experiment is proposed which would test this assumption. A positive result would disagree significantly with the quantum-mechanical prediction. The question of whether or not the new variables must remain unobservable is analyzed mathematically. A rigorous definition of simultaneous measurement is made, and the resulting interference is given a mathematical description. (auth)

46585 GOING OVER FROM CLASSICAL TO QUANTUM MECHANICS. IV. THE CONCEPT OF ENERGY. Ionescu-Pallas, N. J. (Institutul deFizica Atomica, Bucharest). Stud. Cercet. Fiz.,21: 121-6(1969). (In Rumanian).

The relativistic Schrödinger equation for any spin and any gyromagnetic ratio is developed in Schrödinger and Pauli standard form. This is achieved by avoiding the Dirac negative energy states and by performing some unitary transformations which lead to a Hermitian Hamilton function. The wave equation, so obtained, is invariant under space reflection and the wave function contains only the 2S + 1 irreducible components. Among the particularities of this equation, the appearance of a quadrupolar interaction for particles with spin greater than ½ as well as the persistence of spin-orbit coupling for particles with spin is pointed out. (auth)

46586 ROTATION OPERATORS IN QUANTUM MECHANICS. Bouten, M. (SCK, Mol, Belg.). Physica, 42: 572-80(June 12, 1969).

The confusion, existing about the exact form of the rotation operators in quantum mechanics, is cleared up by indicating some well hidden errors in the two standard books on angular momentum. (auth)

46587 INVARIANCE GROUPS OF THE SCHROEDINGER EQUATION FOR THE CASE OF UNIFORM MAGNETIC FIELD. I. Opechowski, W.; Tam, W. G. (Univ. of British Columbia, Vancouver). Physica, 42: 529-56(June 12, 1969).

This paper is an extension of the group theory treatment of the Schroedinger equation of an electron in the presence of an electrostatic, periodic field and a uniform magnetic field, as given by Brown and by Zak. The invariance groups for this case are defined and studied for an arbitrary gauge. In particular, the properties of the invariance translation operator groups and their irreducible representations are considered in detail for all possible orientations and magnitudes of the magnetic field. It turns out that for most orientations and magnitudes of the magnetic field only infinite dimensional representations have a physical meaning. Basis functions generating both finite and infinite dimensional representations are constructed from the eigenfunctions of the Schroedinger equation in the absence of the electrostatic field. Some implications this has for the selection rules for the matrix elements of the electrostatic potential are also dicussed. (auth)

46588 LOWER BOUNDS TO EIGENVALUES. Cohen, Maurice; Feldmann, Tova (Hebrew Univ., Jerusalem). Can. J. Phys., 47: 1877-9(Sept. 1, 1969).

The classical procedure of Weinstein was employed to obtain rigorous upper and lower bounds to the eigenvalues E of a quantum mechanical Hamiltonian operator H. The new bounds represent an improvement over Weinstein's bounds for any reasonable choice of variational trial function. In the case of the lowest eigenvalue E_0, for which the Rayleigh–Ritz procedure gives the optimum upper bound, the new lower bound is an improvement over the lower bound formula of Stevenson and Crawford. (auth)

46589 RANGE OF IMPLANTED BORON, PHOSPHORUS, AND ARSENIC IN SILICON. Davies, D. Eirug (Ion Physics Corp., Burlington, Mass.). Can. J. Phys., 47: 1750-3(Aug. 15, 1969).

Experimental range data for boron, phosphorus, and arsenic implanted into silicon are presented over the energy region from 0.15 to 1.8 MeV, 0.5 to 1.7 MeV, and 1.0 to 1.7 MeV respectively. The range energy dependence at these energies shows the expected predominance of electronic stopping in the case of boron and the increased importance of nuclear stopping for the two heavier ions. (auth)

46590 RELATIVISTIC QUANTUM ENERGY OF A PARTICLE SUBJECT TO GRAVITATIONAL AND ELECTROMAGNETIC ACTIONS. Venini, Carlo. Atti Accad. Naz. Lincei, Rend., Cl. Sci. Fis., Mat. Natur., 45: 283-92(Nov. 1968). (In Italian).

Within the framework of relativistic quantum mechanics, the behavior of a material and electrically charged particle, affected by gravitational and electromagnetic actions is determined. In order to integrate the equation of state, the energy of the particle is restricted to assume only particle numerical values; more exactly, a discrete spectrum of energy levels is obtained. By regarding, at the limit, the square of the speed of light in vacuum as being infinite, the well-known results of nonrelativistic quantum theory are reached. (auth)

PHYSICS (HIGH ENERGY)

Particle Interactions and Properties (Experimental)

Refer also to abstracts 45546 and 46625.

46591 RECENT DEVELOPMENTS IN PARTICLE PHYSICS. Alvarez, Luis W. (Univ. of California, Berkeley). Science, 165: 1071-91(Sept. 12, 1969).

A review of developments in particle physics is presented in this Nobel Prize lecture. Early particle discoveries, strange particles, bubble chamber development, measuring machines, computer and computer programs, various particle interactions and decays, muon catalysis, nonconservation of parity in beta decay, the hyperon (Ξ^0), strange resonances, the meson (ρ) are discussed. Also covered are η and ω particles, the $Y_0^*(1520)$, the Ω particle, and the Eightfold Way. (J.F.P.)

Electromagnetic

46592 (LNF-68/73) PHOTODISINTEGRATION AND PHOTOPRODUCTION IN ^{3}He WITH A DIFFUSION CHAMBER. Note No. 422. Goggi, G.; Mantovani, G. C.; Piazza, A.; Piazzoli, A.; Scannicchio, D. (Comitato Nazionale per l'Energia Nucleare, Frascati (Italy). Laboratori Nazionali di Frascati). Dec. 10, 1968. 27p. (In Italian). Dep.

The preliminary results obtained in a study of the photoreactions of π meson in ^{3}He made with a diffusion chamber were reported. These results on the photodecay into two and three bodies show a substantial agreement with that of other authors. With respect to photoproduction, these results are characterized by high values of the η factor, especially in the case of double photoproduction. The elasticity ratio is in agreement with theoretical calculations. Different angular distributions were obtained for π^+ and π^-. Tentative interpretations of the experimental data were presented. (J.S.R.)

46593 SEARCH FOR FASTER-THAN-LIGHT PARTICLES. Davis, Michael B.; Kreisler, Michael N.; Alvaeger, Torsten (Princeton Univ., N. J.). Contract AT(30-1)-2137. Phys. Rev., 183: 1132-3(July 25, 1969).

An experimental search for the existence of charged particles that propagate with velocities always greater than that of light in a vacuum was performed. Subject to some assumptions regarding the behavior of such particles, it is found that the photoproduction cross section in lead is less than 1.7×10^{-33} cm^2. (auth)

46594 MUON–NUCLEON INELASTIC SCATTERING AT HIGH MOMENTUM TRANSFERS. McNulty, P. J.; Jain, P. L. (State Univ. of New York, Buffalo). Phys. Rev., 183: 1160-8(July 25, 1969).

The inelastic interactions of high-energy muons in nuclear emulsions were investigated using a monoenergetic beam of 5-GeV/c muons produced at the Brookhaven A.G.S. The projected angular divergence of the incident beam was found to be less than 2°, and the contamination by pion-induced events is estimated at 0.2%. A total of 134 events were located by area scanning of the emulsion pellicles. The energies of the scattered muon and, whenever possible, the shower particles were measured by the method of multiple scattering. These tracks were then identified by the well-known g^*-$|p|\beta c$ method. The spectrum of single mesons produced agrees with predictions of the Williams–Weizsäker method and previous electron scattering data. The integral distributions of transferred energy and four-momentum transferred are shown to be in agreement with quantum electrodynamics. No evidence was found for an anomalous scattering in pion production previously reported by cosmic-ray workers. (auth)

46595 THE ENERGY-LOSS SPECTRUM OF EXTENSIVE AIR SHOWERS RECORDED BY THE HAVERAH PARK 500 m ARRAY. Hollows, J. D.; Hunter, H. W.; Suri, A. N. (Univ. of Leeds, Eng.). J. Phys., A (London), 2: 591-604(Sept. 1969).

An integral energy-loss spectrum of air showers is presented for each of four zenith angle intervals 0°–20°, 20°–30°, 30°–35° and 35°–40°, based on 2950 showers selected from over 30,000 recorded by the Haverah Park 500 m air shower array in a running time of 6.4×10^7 s. The energy loss of a shower is defined as the energy dissipated by the shower in an annulus of water 1.2 m thick in the range of distance 100 to 1000 m from the shower axis. The array consisted of three water-filled Cherenkov detectors, each of area 34 m^2 and depth 1.2 m, symmetrically disposed at a radius of 500 m about a similar central detector. The mean altitude of the array was 220 m above sea level. The energy-loss spectra for the four zenith angle intervals may be represented by power laws of exponent -1.94 ± 0.06, -2.10 ± 0.06, -2.26 ± 0.09 and -2.22 ± 0.10, respectively, over the energy-loss range $10^{14.6}$–$10^{15.6}$ eV. This corresponds, in so far as the relation between energy loss and primary energy has been established, to primary energies in the range 10^{17}–10^{18} eV. The zenith angle distribution of the selected showers was consistent with exponential atmospheric absorption with an absorption length of 150 ± 5 g cm^{-2}. The results show no indication of a change in the slope of the primary cosmic-ray energy spectrum within the energy range 10^{17}–10^{18} eV. (auth)

46596 EVIDENCE OF QUARKS IN AIR-SHOWER CORES. McCusker, C. B. A.; Cairns, I. (Univ. of Sydney). Phys. Rev. Lett., 23: 658-9(Sept. 22, 1969).

In a study of air-shower cores using a delayed-expansion cloud chamber, a track was observed for which the only explanation seen is that it is produced by a fractionally charged particle. (auth)

46597 COMPARISON OF ELECTRON–PROTON AND POSITRON–PROTON ELASTIC SCATTERING CROSS SECTIONS. Cassiday, George Lawrence Jr. Ithaca, N. Y., Cornell Univ., 1968. 170p.

Thesis.

The ratio of electron-proton and positron-proton elastic scattering differential cross sections under an identical kinematical configuration was investigated. The lepton beam was made by allowing the external bremsstrahlung γ beam from the Cornell 2-GeV synchrotron to strike a 1-radiation-length lead target. Electrons or positrons were then selected by a beam transport system which momentum analyzed and focused them on a 46-cm-long liquid-H_2 target. The energy of the beam was maintained at 1700 ± 42 MeV. The mean energy difference of the positron and electron beam was less than 0.2%. The pion contamination was kept to a negligible amount by operating the synchrotron at 1875 MeV. The average beam intensity was 2×10^6/sec for positrons or electrons. The thin-foil spark chambers, scintillation counters, and lead-glass Cherenkov counters that were used were arranged symmetrically about the incident beam to detect an event. There were 1342 positron and 1316 electron events obtained at an average q^2 of 20 f^{-2} and 1264 positron and 1278 electron events at an average q^2 of 27 f^{-2}. The cross section ratios ($\Delta\sigma e^+p/\Delta\sigma e^-p$) at these respective q^2 are 0.983 ± 0.039 and 0.959 ± 0.040. This includes both radiative corrections and energy difference corrections. (auth)

Weak

46598 (UCI-10-P-19-9) NEUTRINO EXPERIMENTS AT REACTORS. Reines, F.; Gurr, H. S. (California Univ., Irvine); Jenkins, T. L.; Munsee, J. H. (Case-Western Reserve Univ., Cleveland, Ohio). [1965]. 12p. (CONF-680936-2). Dep. CFSTI.

From Meeting on Neutrino Physics, Moscow, USSR.

A description is given of the $\bar{\nu}_e$ program using a large fission reactor. A search was made for a neutral weak interaction via the reaction $\bar{\nu}_e + d \rightarrow p + n + \bar{\nu}_e$, the reaction $\bar{\nu}_e + d \rightarrow n + n + e^+$ has now been detected, and an effort is underway to observe the elastic scattering reaction $\bar{\nu}_e + e^- \rightarrow \bar{\nu}_e + e^-$ as well as to measure more precisely the reaction $\bar{\nu}_e + p \rightarrow n + e^+$. The upper limit on the elastic scattering reaction which was obtained with the large composite NaI, plastic, liquid scintillation detector is now about 50 times the predicted value. (auth)

46599 (UCI-10-P-19-11) HIGH ENERGY NEUTRINOS UNDERGROUND. Reines, F.; Gurr, H.; Kropp, W.; Lathrop, J.; Sandie, W. (California Univ., Irvine); Crouch, M. F.; Sobel, H.; (Case-Western Reserve Univ., Cleveland, Ohio); Sellschop, J. P. F.; Meyer, B. (University of the Witwatersrand, Johannesburg (South Africa)). [1967]. 8p. (CONF-680936-3). Dep. CFSTI.

From Meeting on Neutrino Physics, Moscow, USSR.

In 2.5 years of operation 10,600 feet underground with an initial large area scintillation detector array, 34 events were observed which are attributed as clearly due to neutrinos and 376 events most of which are attributable to cosmic ray muons. These results are being analyzed for detailed comparison with theoretical expectations. A preliminary analysis reveals no surprising features. Having detected a neutrino signal, a new and improved

laboratory and detector have been constructed in the same mine (East Rand Proprietary Mine, near Johannesburg) at the slightly greater depth of 10,800 feet. The detector consists of 190 m^2 of liquid scintillator slabs which trigger flash tubes for track identification. With this arrangement it is expected to see ~70 neutrino interactions per year with an angular resolution of ±1° and a spatial resolution of 2 cm, a great improvement on all counts over the first detector. At present, three out of sixteen bays were brought into partial operation with completion planned for the coming year. (auth)

46600 NEW MEASUREMENT OF THE K_2 BRANCHING RATIO. Morfin, J. G.; Sinclair, D. (Univ. of Michigan, Ann Arbor). Phys. Rev. Lett., 23: 660-3(Sept. 22, 1969).

The K_2^0 charged-to-neutral branching ratio was measured by examining ~25,000 K^+ charge-exchange reactions in a Freon bubble chamber. The result, 2.10 ± 0.06, is in poor agreement with a recent measurement by Gobbi et al., who obtained a value of 2.285 ± 0.055, while it is in fairly good agreement with the average of earlier experiments. (auth)

46601 51 000 τ-DECAYS. Mast, Terry S.; Gershwin, Lawrence K.; Alston-Garnjost, Margaret; Bangerter, Roger O.; Barbaro-Galtieri, Angelo; Murray, Joseph J.; Solmitz, Frank T.; Tripp, Robert D. (Univ. of California, Berkeley). Phys. Rev., 183-1200-7(July 25, 1969).

An analysis was made of 51,000 $K^- \rightarrow \pi^-\pi^-\pi^+$ decays in flight in the Berkeley 25-in. hydrogen bubble chamber. After corrections for detection efficiency and Coulomb interactions, the projections of the pion spectra were fitted with expansions in the Dalitz variables X and Y. In addition, maximum-likelihood fits to the entire Dalitz plot were made. The decay distribution is well described by 1 + aY, where the slope a = 0.247 ± 0.009. Comparison of this slope with that derived from a world compilation of 28,000 τ^+ decays shows no evidence for CP violation. An isospin analysis of the rates and slopes of τ, τ', and of $K_2^0 \rightarrow 3\pi$ decays, requires, in addition to the dominant $\Delta I = \frac{1}{2}$ amplitude, $\Delta I = \frac{3}{2}$ amplitudes into both I = 1 and I = 2 three-pion final states. No detectable $\Delta I = \frac{5}{2}$ or $\Delta I = \frac{7}{2}$ amplitudes are required. (auth)

46602 DALITZ PLOT DENSITY ANALYSIS IN $K_{\mu 3}^+$ DECAY. Haidt, D. (Technische Hochschule, Aachen); Schepers, H.; Stein, J.; (and others). Phys. Lett., 29B: 691-5(Aug. 18, 1969).

A sample of K^+ mesons stopped in the CERN 1.1 m^3 heavy-liquid bubble chamber was used to study the $K_{\mu 3}^+$ Dalitz plot density and hence to examine the four-momentum dependence of the form factors $f_+(q^2)$ and $\xi = f_-(q^2)/f_+(q^2)$. The result of a three-parameter fit is: $\lambda_+ = 0.053^{+0.018}_{-0.021}$, $\xi(0) = -0.4^{+0.5}_{-0.5}$, $\xi(6.8\ m_\pi^2) = -0.80 \pm 0.50$. The variation of the optimum value for ξ with λ_+ is described. (auth)

Strong (Baryon-Induced)

Refer also to abstract 46908.

46603 (BNL–13918) PERIPHERAL PROCESSES IN PROTON–PROTON INTERACTIONS AT 29 GeV/c. Ellis, W. E.; Morris, T. W.; Panvini, R. S.; Turkot, F. (Brookhaven National Lab., Upton, N. Y.). July 28, 1969 18p. (CONF-690813-4). Dep. CFSTI.

From High Energy Physics Conference, Boulder, Colo.

Bubble chamber and missing-mass-spectrometer data are combined to study details of peripheral, quasi-two-body p-p interactions: p + p → p + M. Distributions as a function of momentum transfer t to the recoil proton and of the mass M are measured for the total interaction and for specific particle compositions of M. t-distributions are found to be exponential, with a change in slope at $t \approx 0.2\ GeV^{-2}$. At low t, the slope is a strong function of mass M, but is nearly constant with mass at large t. Enhancements in the mass distributions at 1.4 and 1.7 GeV are analyzed. (auth)

46604 (JINR–E1-4650) T-INVARIANCE CHECK IN 635-MeV ELASTIC PROTON–PROTON SCATTERING. Zulkarneev, R. Ya.; Nadezhdin, V. S.; Satarov, V. I. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Nuclear Problems). 1969. 8p. Dep. CFSTI (U. S. Sales Only).

"Polarization-asymmetry" equality following from interaction T-invariance was checked in pp-scattering at 635 MeV. No effects of T-invariance violation were found in the angle region of (34 to 117°) c.m.s., the experimental accuracy being 2 to 4%. The T-nonparity scattering amplitude was estimated. The value of sin $\lambda_2 = -0.11 \pm 0.10$ was found for the noninvariance phase λ_2. (auth)

46605 (NYO-2171-286) PRODUCTION OF BOSON RESONANCES IN THE REACTION p + d → ^{3}He + X^0 USING A NOVEL MISSING-MASS SPECTROMETER. Brody, H.; Groves, E.; VanBerg, R.; Wales, W. (Pennsylvania Univ., Philadelphia); Maglic, B.; Norem, J.; Oostens, J. (Rutgers-The State Univ., New Brunswick, N. J.); Schluter, R. (Argonne National Lab., Ill. Northwestern Univ., Evanston, Ill.); Cvijanovich, G. (Uppsala Univ. (Sweden)). Aug. 1969. 12p. Dep. CFSTI.

A missing mass spectrometer which uses a magnet bending particles vertically and simultaneously focussing them horizontally with the fringe field, has been set up at the Princeton-Pennsylvania Accelerator. The spectrometer operates at the maximum (Jacobian) angle for the ^{3}He particles from the reaction p + d → ^{3}He + MM^0. Using this instrument, the neutral boson spectra of I = 0 and 1 are being investigated over the range from 0 to 1150 MeV. The π, η^0 and ω^0 as well as a shoulder near 300 MeV have been observed. (auth)

46606 $\bar{p}$-p ELASTIC SCATTERING AT 8 AND 16 GeV/c. Birnbaum, D. (Carnegie-Mellon Univ., Pittsburgh); Edelstein, R. M.; Hien, N. C.; (and others). Phys. Rev. Lett., 23: 663-6 (Sept. 22, 1969).

Angular distributions are presented for $\bar{p}$-p elastic scattering at 8 and 16 GeV/c for $|t| < 1.3\ (GeV/c)^2$. At both energies there is structure in the differential cross sections in the region $0.5 \leq |t| \leq 1.0\ (GeV/c)^2$, similar to that observed at lower energies. The diffraction peak continues to expand with increasing incident momentum. (auth)

46607 RESONANCE PRODUCTION IN MULTIPARTICLE FINAL STATES IN K^+p INTERACTIONS AT 9 GeV/c. Alexander, Gideon; Firestone, Alexander; Goldhaber, Gerson (Univ. of California, Berkeley). Phys. Rev., 183: 1168-73(July 25, 1969).

Results are presented on the five- and six-body final states $K^0p\pi^+\pi^+\pi^-$ and $K^0p\pi^+\pi^+\pi^-\pi^0$ in K^+p interactions at 9 GeV/c. Copious production of known resonances such as N_{1236}^{*++}, K_{890}^*, K_{1420}^*, ρ, and ω are observed. In addition, there are significant mass enhancements in the A_1 and A_2 mass regions with mass and width values of M_{A_1} = 1060 ± 20 MeV, Γ_{A_1} = 160 ± 20 MeV and M_{A_2} = 1290 ± 20 MeV, Γ_{A_2} = 50 ± 10 MeV, respectively. (auth)

46608 ANNIHILATIONS $\bar{p}n$ AT REST INTO FINAL STATES CONTAINING K-MESONS. Bettini, A. (Univ. Padua. Istituto Nazionale di Fisica Nucleare, Padua); Cresti, M.; Limentani, S.; (and others). Nuova Cim., 62A: 1038-56(Aug. 21, 1969).

An analysis was made of $2.22 \cdot 10^5$ $\bar{p}n$ annihilations at rest into final states with two K-mesons and pions. The annihilation rates into three-body ($K\bar{K}\pi$) and four-body ($K\bar{K}\pi\pi$) final states are found to be comparable, whereas the rates for the five-body states ($K\bar{K}\pi\pi\pi$) are one order of magnitude lower, with the exception of the rate for the quasi-three-body state $K^-K_1^0\omega$. No signal for the production of the $K\pi\pi$ resonance C or for the $K\bar{K}\pi$ resonance E is observed. These results are compatible with the production of C and E mesons from $\bar{p}p$ annihilations at rest if the isospin of C is ½ and that of E is 0, but not if I(C) = ⅗ and I(E) = 1. (auth)

Strong (Meson-Induced)

Refer also to abstract 46729.

46609 (CEA-R–3543) STUDY OF THE REACTION $\pi^-p \rightarrow \pi^-\pi^0p$ AT 2.77 GeV/c FOR LOW MOMENTUM TRANSFER TO THE PROTON. APPLICATION TO THE CHEW–LOW EXTRAPOLATION METHOD FOR THE $\pi^-\pi^0$ ELASTIC SCATTERING. Baton, Jean-Pierre (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). June 1969. 102p. (In French). Dep. CFSTI (U.S. Sales Only).

Thesis. Submitted to Univ. of Paris, Orsay, France.

Study of the reaction $\pi^-p \rightarrow \pi^-\pi^0p$ at 2.77 GeV/c carried out in the CERN 2-m liquid hydrogen bubble chamber at the proton synchrotron, shows that 70 per cent of this reaction goes through $\pi^-p \rightarrow \rho^-p$ channel. The high statistics allow one to specify the mass and the width of the ρ^- resonance. On other hand, if the ρ^- production parameters are independent of the ρ^- width, it is not the same case for the decay parameters. The Chew-Low extrapolation method allows one to determine the $\pi^-\pi^0$ elastic cross section to the pole, and the phase shifts of the P waves in the isospin-1 state and S waves in the isospin-2 state. (auth)

46610 (ORO–3065-17) PROGRESS REPORT [ON HIGH-ENERGY PHYSICS], JULY 1, 1968–JUNE 30, 1969. Fowler, Earle C. (Duke Univ., Durham, N. C.). Aug. 5, 1969. Contract AT(40-1)-3065. 8p. Dep. CFSTI.

An administrative review of research on the K^- + p interactions

at 740 MeV/c is reported for the period from July 1, 1968, to June 30, 1969. Personnel activities and equipment are also discussed. (J.F.P.)

46611 (PPAR-16) EVIDENCE FOR A $\Lambda\pi^+$ RESONANCE AT 1480 MeV. Pan, Yu-Li; Forman, Fred L. (Princeton-Pennsylvania Accelerator, Princeton, N. J.). July 17, 1969. Contract AT(30-1)-2171. 10p. Dep. CFSTI.

An enhancement in the $\Lambda\pi^+$ mass spectrum was observed at 1480 MeV in the reaction $\pi^+p \rightarrow K^+\pi^+\Lambda$ at 1.7 GeV/c. In addition, the Λ polarization undergoes a sharp oscillation in the same $\Lambda\pi$ mass region. The best fit values for this resonance are M = 1480 ± 15 MeV and Γ = 35 ± 20 MeV. (auth)

46612 (PPAR-17) OBSERVATION OF THE $Y_1^*(1475)$ IN THE $(\Sigma\pi)^+$ SYSTEM; COMMENTS ON SPIN AND SU(3) MULTIPLET ASSIGNMENT. Forman, Fred L.; Pan, Yu-Li (Princeton-Pennsylvania Accelerator, Princeton, N. J.). July 17, 1969. Contract AT(30-1)-2137. 9p. Dep. CFSTI.

The observation of a resonance in the $\Lambda\pi^+$ system at 1480 MeV was recently reported. The $(\Sigma\pi)^+$ decay of this same resonance was observed in the reactions $\pi^+p \rightarrow K^+\Sigma^+\pi^0$ and $\pi^+p \rightarrow K^+\Sigma^0\pi^+$ at a mass of 1465 ± 20 MeV and a width of 25 ± 20 MeV. The weighted averages are then M = 1475 ± 15 MeV and Γ = 30 ± 15 MeV. The $\Sigma\pi/\Lambda\pi$ branching ratio for the $Y_1^*(1385)$ and the $Y_1^*(1475)$ were determined to be 0.15 ± 0.05 and 0.68 ± 0.40 respectively. A comment is made on the spin of the $Y_1^*(1475)$ and its possible SU(3) multiplet assignment. (auth)

46613 (UCRL-19263) STRANGE PARTICLE PRODUCTION IN π^+d INTERACTIONS FROM 1.1 TO 2.4 GeV/c. Davies, Donald Wayne (California Univ., Berkeley. Lawrence Radiation Lab.). July 1969. Contract W-7405-eng-48. 72p. Dep. CFSTI.

Thesis.

We have studied properties of strange-particle final states arising from reactions of 1.1–2.4 GeV/c π^+ mesons on deuterium. Total cross sections on deuterium are presented, and three reactions are analyzed in terms of the impulse model. $Y^*(1385)$ production dominates the $n\Lambda K^+\pi^+$ final state, and the reaction is described near threshold adequately by a K^* exchange model. The $n\Sigma^+K^0\pi^+$ final state is found to be primarily $n\Sigma^+K^{*+}$. $\phi(1020)$ and $\Lambda(1520)$ are seen in the ppK^+K^- final state. (auth)

46614 OMEGA PRODUCTION IN $\pi^+d \rightarrow \pi^+\pi^-\pi^0pp$ AT 4.19 GeV/c. Abrams, G. S.; Eisenstein, B.; Gordon, H. (Univ. of Illinois, Urbana). Phys. Rev. Lett., 23: 673-6(Sept. 22, 1969).

Approximately 340 events of the reaction $\pi^+n \rightarrow \omega^0p$ at a beam momentum of 4.19 GeV/c were studied. The differential cross section shows neither a broad dip for $t < -0.2$ $(GeV/c)^2$ nor a dip in the region $t \approx -0.6$ $(GeV/c)^2$. There is a 2-standard-deviation dip in ρ_{10} between $t = -0.2$ and $t = -0.3$ $(GeV/c)^2$ and a small negative value of $Re\rho_{10}$ for $t < -1.0$ $(GeV/c)^2$. The dip in ρ_{10} is consistent with the vanishing, in that region of t, of an exchanged trajectory with unnatural parity. A simple Regge-model calculation with ρ + B exchange does not reproduce the data. (auth)

46615 RESOLUTION OF THE T = 0 FERMI-YANG AMBIGUITY IN K-NUCLEON SCATTERING. Ray, A. K. (Carnegie-Mellon Univ., Pittsburgh); Burris, R. W.; Fisk, H. E.; Kraemer, R. W.; Hill, D. G.; Sakitt, M. Phys. Rev., 183: 1183-6(July 25, 1969).

From an exposure of the BNL 30-in. deuterium-filled bubble chamber to a 600-MeV/c K^+ beam, the angular distribution (14,912 events) and polarization (853 double-scattered events) for the charge-exchange reaction were obtained. The results of partial-wave analyses of the data indicate the dominance of a positive $P_{\frac{1}{2}}$ phase shift, and consequently establish a T = 0 Yang-type solution. (auth)

46616 STUDY OF $\pi^-p \rightarrow \Sigma^-K^+$ FROM 1.12 TO 1.32 BeV/c. Good, Myron L.; Kofler, Richard R. (Univ. of Wisconsin, Madison). Phys. Rev., 183: 1142-8(July 25, 1969).

Total cross sections, angular distributions, and decay asymmetries were measured for the reaction $\pi^-p \rightarrow \Sigma^-K^+$ at pion beam momenta of 1.12, 1.23, 1.27, and 1.32 BeV/c. Legendre-polynomial expansion coefficients for the angular distributions are presented and compared with other data. Preliminary results of a partial-wave analysis are discussed. (auth)

46617 INELASTIC π^+n INTERACTIONS IN THE CENTER-OF-MASS ENERGY RANGE 1.40 TO 1.65 GeV. Litchfield, P. J. (Rutherford High Energy Lab., Chilton, Eng.). Phys. Rev., 183: 1152-9(July 25, 1969).

The reactions $\pi^+ + n \rightarrow p + \pi^+ + \pi^-$ and $\pi^+ + n \rightarrow p + \eta$ were studied as a function of the π^+n center-of-mass energy in the range 1.40 to 1.65 GeV, using π^+ interactions in deuterium and the impulse approximation. Within specified limits, the data are shown to be consistent with this approximation. The relative cross sections for $\pi^+ + n \rightarrow p + \pi^+ + \pi^-$ were obtained at 13 points in the energy range, with a standard deviation of 4% at the center, rising to 10% at the extreme energies. There is a clear enhancement in the region of the N*(1470) and N*(1518), and the cross section rises steeply at the higher energies. The rapid rise and subsequent decay of the η-production cross section is confirmed. From the η-production angular distributions, evidence for the decay of the N*(1680) and N*(1688) into ηp is found, together with an indication that the N*(1470) may decay in this mode. (auth)

46618 PRODUCTION OF Λ^0 AND Σ^0 HYPERONS BY PIONS OF BEAM MOMENTA 1.12 TO 1.32 BeV/c. Binford, T. O.; Good, M. L.; Lind, V. G.; Stern, D.; Krauss, R.; Dettman, E. (Univ. of Wisconsin, Madison). Phys. Rev., 183: 1134-42(July 25, 1969).

Total cross sections, angular distributions, and polarization distributions were measured for the reactions $\pi^-p \rightarrow \Lambda^0K^0$ and $\pi^-p \rightarrow \Sigma^0K^0$ at beam momenta of 1.12, 1.23, 1.27, and 1.32 BeV/c. Legendre-polynomial expansion coefficients for angular distributions and polarization distributions are presented and compared with other data. Two approximate cross-section equalities are demonstrated among $I = \frac{1}{2}$ total cross sections over a wide range of energies: $\sigma_{I=\frac{1}{2}}(\Sigma K) \cong \sigma(\Lambda K)$, and $\sigma(\eta N) \cong \sigma(\Lambda K) + \sigma_{I=\frac{1}{2}}(\Sigma K)$ where $\sigma(\eta N)$ is the total cross section for $\pi^-p \rightarrow \eta n$. Hyperon decay asymmetries observed in the reaction $\pi^-p \rightarrow \Lambda K^0$ are difficult to reconcile with a value of $\alpha_\Lambda = 0.66$. (auth)

46619 MULTIPLE STRANGE-PARTICLE PRODUCTION BY 6 GeV/c K^--MESONS IN HYDROGEN. Scotter, D. G. (Univ. of Birmingham, Eng.); Erskine, R.; Paler, K.; Sisterson, K.; Blum, W.; Gandini, F.; Ochs, W.; Allison, J. Nuovo Cim., 62A: 1057-81(Aug. 21, 1969).

A bubble-chamber experiment with approximately 5 events per μb on multiple strange-particle production is reported. A large number of total production cross sections is given including values for the $\Xi^*(1530)$, $K^*(890)$, $\varphi(1020)$ and $f'(1520)$ resonances. An attempt was made to determine the average polarization of the Ξ^--particle in various final states. The mass distributions as well as the production angles relevant to some final states are also discussed. (auth)

46620 ANALYSIS OF PION–PION SCATTERING THROUGH CHEW–MANDELSTAM EQUATION. Furuichi, Susumu (Rikkyo Univ., Tokyo); Kanada, Hiroyuki; Watanabe, Keiji. Progr. Theor. Phys. (Kyoto), 42: 50-5(July 1969).

Low energy pion–pion scattering is investigated by using the Chew-Mandelstam representation. By treating the cutoff momentum as an adjustable parameter, an excellent agreement with experiment has been obtained for the S waves without using the CDD ambiguity. The P-wave solution is also consistent with experiment. The agreement is better than that calculated by using the momentum dependent Breit-Wigner formula. (auth)

46621 ELASTIC SCATTERING OF PIONS, KAONS, AND ANTIPROTONS FROM HYDROGEN AT 6, 8, 10, AND 14 GeV/c. Peterson, Francis Carl. Ithaca, N. Y., Cornell Univ., 1968. 104p.

Thesis.

An experiment to measure π^-p, K^-p, and $\bar{p}p$ elastic scattering by means of scintillation counters and optical spark chambers was completed at the Brookhaven alternating gradient synchrotron. Results are presented for π^-p, K^-p, and $\bar{p}p$ scattering in the range of invariant four-momentum transfer squared, t, from –0.7 to –6 $(GeV/c)^2$ at a momentum of 6 GeV/c, for π^-p scattering in the t range –5 to –10 at 8 GeV/c, for π^-p scattering in the range –0.7 to –13 at 10 GeV/c, for K^-p and $\bar{p}p$ scattering in the range –0.7 to –6 at 10 GeV/c, and for π^-p and K^-p scattering in the range –1 to –2.5 at 14 GeV/c. (Disser. Abstr.)

46622 KINEMATICAL AND DYNAMICAL STRUCTURE IN THE SIX-PRONG CHANNELS OF 3.2-GeV/c π^-p INTERACTIONS. Allen, Royce Hyrum. Logan, Utah, Utah State Univ., 1968. 109p.

Thesis.

In this experiment 1077 six-prong events at π^- beam momentum of 3.2 GeV/c were analyzed yielding a production cross section $\sigma = 121.7 \pm 3.7$ μb. The data used were 137,000 pictures taken on the 72-inch hydrogen bubble chamber at Lawrence Radiation Laboratory, Berkeley, California. All effective mass distributions obtainable from the final states $\pi^-\pi^-\pi^-\pi^+\pi^+n$, $\pi^-\pi^-\pi^-\pi^+\pi^+p$, and $\pi^-\pi^-\pi^-\pi^+\pi^+p\pi^0$ are presented as well as the cross sections of these final states. It was found that the quasi-two-body isobars dominated the resonance production channels and the associated partial cross-sections are presented. Other resonances seen were the $\omega^0(783)$, $\eta^0(549)$, and $\eta'(958)$. The average momentum transfer in the resonance production was found to peak nearer 1.0 $(GeV/c)^2$

rather than the usual values near zero. In addition angular correlation information for all pion pairs is presented. (Disser. Abstr.)

Particle Interactions and Properties (Theoretical)

General

Refer also to abstracts 46810 and 46818.

46623 (IC-69/76) QUASIPOTENTIAL EQUATIONS FOR TWO PARTICLES OF UNEQUAL MASS. Bogolubov, P. N. (International Centre for Theoretical Physics, Trieste (Italy)). July 1969. 13p. Dep.

The high-energy elastic scattering of two unequal-mass particles is considered. The discussion covers some possible forms of the quasipotential equations for the case when one particle is spin-½ and the other is spinless and quasipotential equations for two particles with spin-½ in the form of two equations. (J.F.P.)

46624 A METHOD OF GENERATING MONTE CARLO EVENTS WITH SMALL TRANSVERSE MOMENTA OF SECONDARIES. Pene, O. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France); Krzywicki, A. Nucl. Phys., B12: 415-25(1969).

A new method of generating random multi-particle events is discussed. The population of events with small transverse momenta of secondaries is enriched, which makes the method particularly suitable for a study of ultrahigh energy collisions. A FORTRAN program was written and may be sent to interested readers on request. (auth)

46625 ELEMENTARY PARTICLES AND THEIR INTERACTION FORCES. Pietschmann, Herbert (Univ., Vienna). Naturwissenschaften, 56: 164-9(Apr. 1969). (In German).

A review is given of the present knowledge on elementary particles and their interaction forces. A description is given of elementary particles. The lifetime of elementary particles is considered. A classification scheme is given for the elementary particles. Elementary particle processes are also considered. (J.S.R.)

46626 IMPLICATIONS OF CAUSALITY FOR FASTER-THAN-LIGHT MATTER. Rolnick, William B. (Wayne State Univ., Detroit). Phys. Rev., 183: 1105-8(July 25, 1969).

A causal anomaly for signals or particles traveling faster than the speed of light is described. The reinterpretation of "negative-energy particles traveling backwards in time" as positive-energy particles traveling forward in time fails to resolve the paradox. Uncertainties in velocities and times introduced by quantum-mechanical considerations also fail to resolve the paradox. (auth)

46627 COMPLETENESS OF THE SOLUTIONS OF THE MAJORANA WAVE EQUATIONS. Mukunda, N. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 183: 1486-95 (July 25, 1969).

It is proved by analytic methods that the timelike and spacelike solutions of the infinite-component relativistic Majorana wave equations, taken together, constitute a complete set of solutions of those equations. (auth)

46628 TENSOR- AND SCALAR-MESON DOMINANCE. West, Geoffrey B. (Harvard Univ., Cambridge, Mass.). Contract AT(30-1)-2076. Phys. Rev., 183: 1496-8(July 25, 1969).

Mass formulas are derived by saturating spectral-function sum rules for tensor currents with the 2^+ and 0^+ mesons. By associating certain of these tensors with the physical stress-energy tensor, verifiable universality-type relationships are derived. (auth)

46629 CONNECTION BETWEEN CURRENT-DENSITY ALGEBRAS AND CHARGE-CURRENT ALGEBRAS. Voelkel, U.; Voelkel, A. H. (Univ. of Pittsburgh). Contract AT(30-1)-3829. Nuovo Cim., 63A: 203-37(Sept. 1, 1969).

The equal-time limit of commutator matrix elements of charge densities is calculated by means of structures which follow from general principles of quantum field theory, especially locality and divergence conditions. It is shown that these structures imply the occurrence of at least three gradient terms. Therefore the demand that no gradient terms occur in the equal-time limit of charge densities represents nontrivial sum rules. Explicit expressions in form of energy integrals over commutator matrix elements are constructed for the coefficients of the δ-functions and their derivatives. It is proved that these coefficients are also given by equal-time limits of commutators between moments of total charges and charge densities. In contrast to the Dashen-Gell-Mann frame in all terms one-particle contributions of any mass and spin occur only in the form of coupling constants times form factors. The vanishing of the gradient terms in combination with saturation assumptions leads to ordinary linear differential equations in momentum transfer for the form factors. (auth)

46630 AN ALTERNATIVE FORMULATION OF THE REPRESENTATION OF THE ISOVECTOR CURRENT-DENSITY. Miyazaki, Tadashi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 125-7(July 1969).

An alternative formulation of the representation of the isovector current-density, appropriate to space-fixed co-ordinate system, is presented and thereby are obtained more stringent conditions than those of Gell-Mann et al. (auth)

46631 CAN EQUATIONS OF MOTION BE USED. Dirac, P. A. M. (Cambridge Univ., Eng. Univ. of Miami, Coral Gables, Fla.). pp 1-18 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

It is argued that the theory of high energy physics must be based on equations of motion in order to achieve unity of the whole of physical theory. A method for development of the theory based on the equations of motion is proposed as an alternative to S-matrix theory. (L.B.S.)

46632 CORAL CABLES CONFERENCE ON FUNDAMENTAL INTERACTIONS AT HIGH ENERGY, JANUARY 22-24, 1969. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, Science Publishers, 1969. 414p. (CONF-690110).

Twenty-four papers were presented; separate abstracts were prepared for twenty-two. The other two papers were previously abstracted for NSA and appeared as 23: 27786 and 27837. (L.B.S.)

For abstracts of individual papers see: 46631, 46633, 46634, 46673-46675, 46689-46695, 46735, 46768, 46784, 46810, 46811, 46823, 46825, 46849, and 46850.

46633 SATURATION OF CURRENT ALGEBRA AT INFINITE MOMENTUM. O'Raifeartaigh, L. (Inst. for Advanced Studies, Dublin). pp 83-97 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

It was previously proposed that information concerning the masses and form factors of the elementary particles could be obtained by saturating current algebra by 1-particle states at infinite momentum. Later investigations on the formalism developed by Gell-Mann and Dashen are discussed. The first part deals with the techniques of the infinite-momentum limit, ending with the Gell-Mann-Dashen equations. The second part deals with attempts to find solutions to these equations, considering the case in which all the 1-particle states used for saturation have the same isotopic spin. The possibility of obtaining results for the general case is considered. (L.B.S.)

46634 SPACE-TIME STRUCTURE IN HIGH ENERGY INTERACTIONS. Finkelstein, D. (Yeshiva Univ., New York). pp 324-43 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

The possibility is explored that the ideas of space and time are at the very edge of their domain and are wrong for shorter distances and time, and that high-energy experiments are a probe through which departure from the classical continuum can be discovered. A proposal is outlined for constructing a space-time theory in which from the start the elementary objects which make up the space-time are described by quantum laws and space-time itself is assembled out of these by the quantum-logical procedures used in the quantum many-body problem. (L.B.S.)

46635 HIGH ENERGY PHYSICS INDEX. VOLUME 7, NO. 13, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 65p.

46636 HIGH ENERGY PHYSICS INDEX. VOLUME 7, NO. 14, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 92p.

46637 HIGH ENERGY PHYSICS INDEX. VOLUME 7, NO. 15, 1969. Frankfurt am Main, Zentralstelle fuer Atomkernenergie-Dokumentation, 1969. 73p.

46638 DYNAMICS MOMENTS AND CURRENT ALGEBRAS. Shirokov, Yu. M. (Moscow State Univ.). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 119-30(1968).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

Some rigorous physical and mathematical properties of dynamic moments in current algebra are considered. The asymptotic behavior of the dynamic moments, additional sets of dynamic moments, translation-invariant algebras, and dynamic moments of the energy-stress tensor are covered. (J.F.P.)

46639 ELEMENTS OF ADVANCED QUANTUM THEORY. Ziman, J. M. New York, Cambridge University Press, 1969. 280p. $9.50.

A connected mathematical derivation of important results is presented concentrating on the central ideas without elaborate detail or rigor. Symbols and concepts in solid state nuclear, and high-energy physics, and in theoretical chemistry are explained. Bosons, fermions, perturbation theory, Green functions, aspects of the many-body problem, relativistic formulations, and symmetry algebra are covered. (J.F.P.)

46640 ROLE OF THE MASS IN THE THEORY OF FREE FERMIONS. Lopes, J. Leite; Novello, M. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro, Univ. Federal, Rio de Janeiro). Notas Fis., Cent. Brasil. Pesqui. Fis., 14: No. 11, 351-60(1969).

The possibility of regarding the mass as an operator in Dirac's equation for free fermions is investigated. The mass transformation induced by general coordinate transformations which leave invariant Dirac's equation is obtained and includes mass reversal. Invariance under the Poincaré group imposes strong restrictions on the mass transformation but seems to allow mass reversal. (auth)

Electromagnetic

Refer also to abstracts 45544, 45547, 46677, and 46851.

46641 (DESY-69/22) ELECTROPRODUCTION OF N*(1236) IN A LADDER APPROXIMATION MODEL. Gutbrod, Fritz (Deutsches Elektronen-Synchrotron, Hamburg (West Germany)). July 1969. 50p. Dep. CFSTI (U. S. Sales Only).

Electroproduction of N*(1236) is described by a model, in which the left hand cut of the pion production multipoles is approximated by the sum of ladder diagrams containing nucleon and pion exchange with cut-offs. The cut-off parameters have been fixed by use of scattering and photoproduction data. Taking the cut-offs independent of the virtual photon four momentum, predictions for the two transverse multipoles and for the scalar multipole are given. Special emphasis is laid on a discussion of the resonance shape for different momentum transfer. (auth)

46642 (NP-17999) MULTIPLE SCATTERING CORRECTIONS TO PION-PHOTOPRODUCTION. Note No. 227. Benfatto, G.; Nicolo, F.; Rossi, G. C. (Rome Univ. (Italy). Istituto di Fisica). June 18, 1969. 34p. Dep. CFSTI (U. S. Sales Only).

Following the idea of including in the scattering amplitudes absorptive or multiple scattering corrections, a generalization of the Frautschi-Margolis model is proposed, in which, starting from Regge pole exchanges, one generates multiple scattering corrections in the form of Regge cuts. A detailed application of the model to the high energy π-photoproduction is presented and numerical results are given both for polarized and unpolarized differential cross sections, which are in agreement with experimental data. (auth)

46643 (SLAC-Trans-97) FORMATION AND DECAY OF $(\mu^+\mu^-)$ ATOMS. Bilen'kii, S. M.; Nguyen Van Hieu; Nemenov, L. L.; Tkebuchava, F. G. (Joint Inst. for Nuclear Research, Dubna (USSR)). Translated by R. Addis (Stanford Linear Accelerator Center, Calif.), from report JINR-P2-4438. 6p. Dep. CFSTI.

The production of $(\mu^+\mu^-)$ atoms in particle collisions $\pi^- + p \rightarrow (\mu^+\mu^-) + n$ and $\gamma + Z \rightarrow (\mu^+\mu^-) + Z$ is studied. The cross sections for these processes and the $(\mu^+\mu^-)$ lifetime and decay probabilities are found. Also the decay probabilities of the $(\pi^+\pi^-)$ and $(K^-\pi^+)$ atoms and the lifetime of the $(\pi^+\pi^-)$ atom are given. (J.F.P.)

46644 (UCRL-19211) STOPPING-POWER DIFFERENCES BETWEEN POSITIVE AND NEGATIVE PARTICLES AT LOW VELOCITIES. Heckman, Harry H. (California Univ., Berkeley. Lawrence Radiation Lab.). Apr. 1969. Contract W-7405-eng-48. 23p. (CONF-690422-1). Dep. CFSTI.

From American Physical Society Meeting, Washington, D. C.

Experimental evidence which shows that the rates of energy loss for positive particles exceed those for negative particles at equal velocities when these velocities are comparable to those of the atomic electrons of the stopping medium is presented and discussed. Nuclear emulsion studies of the particle ranges of π^+ and π^- and Σ^+ and Σ^- are described. (W.H.K.)

46645 PHOTOPRODUCTION OF ETA MESONS BELOW 2.0 GeV IN THE GENERALISED INTERFERENCE MODEL. Bajpai, R. P.; Donnachie, A. (Univ. of Glasgow). Nucl. Phys., B12: 274-80(1969).

The generalized interference model is used to fit the available data on eta photoproduction. Using only Reggeized ω and B exchange in the t-channel and the $S_{11}(1510)$ and $P_{11}(1750)$ resonances in the direct channel, an extremely good representation of the data are obtained up to 1.6 GeV photon lab energy. To explain the data in the region of 2 GeV photon lab energy it is necessary to invoke either an additional exchange term or an additional resonance, the latter being the simpler of the two. (auth)

46646 INTERPRETATION OF RECENT EXPERIMENTAL TESTS OF VECTOR-MESON DOMINANCE. Schmidt, W.; Yennie, D. R. (Cornell Univ., Ithaca, N. Y.). Phys. Rev. Lett., 23: 623-6(Sept. 15, 1969).

There are several experiments involving photon interactions with nucleons or nuclei which are in apparent disagreement with the usual predictions of the vector-meson-dominance model. A tentative analysis of these experiments in terms of additional mass dependences arising from the vector-meson amplitudes is presented. (auth)

46647 REGGE-POLE MODEL WITH ABSORPTIVE CORRECTION CUTS FOR π^0 PHOTOPRODUCTION. Blackmon, Maurice L. (Argonne National Lab., Ill.); Kramer, G.; Schilling, K. Phys. Rev., 183: 1452-5(July 25, 1969).

A Regge-pole model with ω- and B-meson exchange and absorptive corrections for π^0 photoproduction on protons is reported. The calculation fits existing data between 3 and 16 GeV fairly well. Further experimental checks of the model are suggested. (auth)

46648 UNIFORM TREATMENT OF PION ELECTRO- AND PHOTOPRODUCTION IN REGGE THEORY. Ebata, T.; Lassila, K. E. (Ames Lab., Iowa). Phys. Rev., 183: 1425-30(July 25, 1969).

The problems associated with the conventional kinematical interpretation of the pion pole in Regge theory are studied. It is found that a formulation leading to a dynamical interpretation is possible in an approach which emphasizes the Lorentz-invariance interpretation of gauge invariance. This approach leads to a uniform treatment of pion production by real and virtual photons in the sense that the former is demanded to be the zero-mass limit of the latter in a manner consistent with Lorentz-invariance requirements on helicity amplitudes, as suggested by Weinberg. The formula for the meson Regge pole has a singularity at $t = \mu^2$ which explicitly comes from a factor $1/\sin\pi\alpha(t)$, rather than the kinematical factor $(t-\mu^2)^{-1}$ used in recent phenomenological analyses. Comments are made on some features arising from gauge invariance which are analogous to perturbation theory. (auth)

46649 THEORETICAL CONSIDERATIONS ON INELASTIC ELECTRON SCATTERING AT HIGH ENERGIES. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev., 183: 1324-35(July 25, 1969).

Physical arguments are presented for the conjecture that, compared with photoproduction and hadronic production, the difficulty in making large transverse momentum transfers at high energies is much less in electroproduction processes when the virtual photon is far off the mass shell. Model calculations are carried out to verify this result. In particular, in the c.m. systems of the outgoing hadrons, the angular distribution of the vector meson produced by the reactions $e^- + p \rightarrow e^- + p + \rho^0$ (or φ, or ω) is less peaked in the forward direction at high energies when the virtual photon is further off the mass shell. This and other possible experimental tests are discussed. This reduction of the forward peaks also makes electroproduction processes a fertile ground for testing statistical theories of high-energy collisions. (auth)

46650 SPECTRAL-FUNCTION SUM RULES AND THE SUGAWARA MODEL. Corrigan, Dennis; Kuriyan, Jacob G. (Univ. of California, Los Angeles). Phys. Rev., 183: 1472-3 (July 25, 1969).

The implications of Sugawara's theory of currents for the properties of the vector and axial-vector spectral functions ρ_V and ρ_A are investigated. Using only the requirement of Lorentz invariance of the equal-time commutators of the components of the stress-energy tensor, it is shown that in order that the theory be nontrivial, the integrals $\int dm^2 \rho_{V,A}(m^2)$ involved in Weinberg's second sum rule must diverge. This in turn enables the asymptotic behavior of the total cross section to be predicted for the process $e^+ + e^- \rightarrow$ hadrons, and is a rigorous consequence of the nontrivial Sugawara model. These arguments, unlike Dashen and Frishman's, apply for the SU(3) version of the Sugawara model as well. (auth)

46651 MOMENTUM TRANSFER DEPENDENCE OF THE γ NN* VERTEX IN A DISPERSION THEORETICAL MODEL. McKay, Douglas Wallace. Evanston, Ill., Northwestern Univ., 1968. 146p.

Thesis.

A new method is proposed and developed to study the momentum-transfer dependence of the electropion production vertex on λ, the square of the effective photon mass, which employs unsubtracted dispersion relations written in terms of the λ variable itself. A model in which only spinless pions, nucleons and photons are included is adopted, and complications of the λ-plane singularity structure are studied which result from the fact that the square of the final state π-N mass, s, is above threshold. Physical unitarity in the λ-channel is extended to apply in unphysical regions and is approximated by the three intermediate states, $\pi\pi$, $N\overline{N}$ and $\pi N\overline{N}$. Thus a closed system of form factors and scattering amplitudes is obtained which are coupled by unitarity. (Diss. Abstr.)

46652 LOW-ENERGY NUCLEAR PHYSICS TEST FOR A POSSIBLE ISOTENSOR COMPONENT OF THE ELECTROMAGNETIC INTERACTION. Blin-Stoyle, R. J. (Univ. of Sussex, Brighton, Eng.). Phys. Rev. Lett., 23: 535-7(Sept. 8, 1969).

It is shown how a comparison of the γ widths for corresponding $T = 3/2 \rightarrow T = 1/2$ transitions in mirror nuclei can give information about a possible isotensor component of the electromagnetic interaction. From data available at present it is concluded that the isotensor γ transition amplitude in the decays considered is less than about 10% of the isovector amplitude. (auth)

46653 ELECTROMAGNETIC MASS DIFFERENCE AND SU(3) BOOTSTRAP MODEL. Miura, Kimio (Tokyo Univ. of Education). Progr. Theor. Phys. (Kyoto), 42: 68-81(July 1969).

Electromagnetic mass difference of hadrons is discussed on the basis of the SU(3) bootstrap model in which electromagnetic mass difference of hadrons comes from the electromagnetic mass differences of bound hadrons, Coulomb interaction and magnetic interaction between bound hadrons. Low-lying states are assumed to be main ingredients of hadrons, for instance Baryon octet (B_8) is bound states of baryon octet and pseudoscalar meson octet (P_8) and those of baryon decuplet (B_{10}) and pseudoscalar meson octet. This is represented in a simple way, $B_8 = (B_8,P_8) + (B_{10},P_8)$. In a similar fashion $B_{10} = (B_{10},P_8) + (B_8,P_8)$, $P_8 = (P_8,V_8) + (V_8,V_8) + (B_8,\overline{B}_8)$, and $V_8 = (P_8,P_8) + (P_8,V_8) + (B_8,B_8)$. It is then found that the p-n mass difference is caused mainly by the electromagnetic mass differences of baryon decuplet. From our qualitative analysis of the electromagnetic mass difference of vector meson in the SU(3) bootstrap model, it is also found that vector mesons tend to dissociate into two pseudoscalar mesons (P state) with dominant probability, namely that Chew's π-π resonance model of ρ meson is the most preferable. (auth)

46654 CALCULATION OF THE RANGE OF HEAVY CHARGED PARTICLES IN COMPLEX SUBSTANCES. Bad'in, V. I. (Inst. of Biophysics, Moscow). Prib. Tekh. Eksp., No. 3, 85-6(May-June 1969). (In Russian).

In order to calculate the range of heavy charged particles in an absorber consisting of a complex substance, it is necessary to know the average mass numbers (A) and the elements present in the substance. At present A is determined from erroneous expressions. A method for determining a true value for A is presented. (tr-auth)

46655 ELECTRON-ELECTRON NEUTRINO BREMSSTRAHLUNG. [PART] II. Cazzola, P. (Univ., Ferrara, Italy. Univ., Padua); Saggion, A. Nuovo Cim., 63A: 367-75(Sept. 1, 1969).

The results of previous work are applied in order to estimate the neutrino energy loss in stars for the process $e^- + e^- \rightarrow e^- + e^- + \nu + \overline{\nu}$ when the gas of electrons is nondegenerate. The results show that the relative contribution of this process in comparison with the overall neutrino production due to pair annihilation, photo-neutrino and plasmon decay never exceeds 1 percent in the non-degeneracy region. An interval of temperatures going from $6 \cdot 10^8$ to 10^{10}°K was investigated; an exact expression for the transition probability, as calculated previously was used owing to the fact that in this interval of temperatures the particles cannot be considered either nonrelativistic or ultrarelativistic. (auth)

46656 POLARIZATION MEASUREMENTS AT HIGH ENERGIES. Saenger, R.; Schmidt, W. (Stanford Univ., Calif.). Ann. Phys. (N. Y.), 54: 307-49(Sept. 1969).

The problem of translating symmetry properties of the helicity amplitudes for two-body scattering into concise predictions for polarization experiments is discussed extensively. Particular attention is given to the asymptotic symmetries at high energies, which are characteristic for a Regge pole exchange model and which are associated with J-parity and G-parity exchange in a crossed channel. The idea is developed that the symmetry operator, as a matrix in the helicity space, "maps" one polarization measurement onto a superposition of other polarization measurements. Using this fact a systematic procedure is presented for separating different parts of the amplitudes which are even or odd under a symmetry. The procedure applies for any spins of the particles. To make this more complete and self-consistent a discussion of the density matrix formalism with particular emphasis on the choice of coordinate systems and phase conventions is included. (auth)

46657 CAUSALITY AND ELECTROMAGNETIC FORM FACTORS. Alvarez-Estrada, R. F. (Junta de Energia Nuclear, Madrid). Ann. Phys. (N. Y.), 54: 276-306(Sept. 1969).

In the annihilation $e^-e^+ \rightarrow \gamma \rightarrow \pi^+ + \pi^-$, the electromagnetic potential of the virtual γ is related to the $\pi^+\pi^-$ wave function by means of a convolution product, under different general conditions (even if the $\pi^+\pi^-$ interdistance approaches infinity). After assuming the boundedness of the pion form factor, F(w), for $w \geq 2m_\pi$ (w is the total energy), general causality conditions are formulated rigorously on the convolution kernels: their vanishing for certain values of time and distance which could correspond, otherwise, to an intuitive violation of causality. The causality conditions imply analyticity and boundedness of F(w) in Im w > 0. General parameterizations of F(w) in the w-plane are presented. The derivative of the phase of F(w) is interpreted as a time delay. As examples of the causality conditions a vector-meson-dominance model, the field theoretic PS – PS coupling model and a new model (where F(w) appears to be the inverse of the $\pi^+\pi^-$ P-wave outgoing Jost function so that its analyticity properties can be derived rigorously) are studied. Arguments are presented to prove that F(w) has no zeroes in Im w > 0. The generalization of the causality conditions to the form factors of the proton, neutron, etc., is also treated. (auth)

46658 PHYSICAL PICTURE FOR HIGH-ENERGY DIFFRACTION SCATTERING. Cheng, Hung (Massachusetts Inst. of Tech., Cambridge); Wu, Tai Tsun. Phys. Rev. Lett., 23: 670-3(Sept. 22, 1969).

Recent theoretical results on high-energy scattering are extended. Explicit rules are given to obtain the high-energy behavior of the sums of large classes of Feynman diagrams. This consideration suggests, for high-energy diffraction scattering, a physical picture which is simple and natural. It is emphasized that this physical picture has the virtue of yielding correctly all the high-energy results of quantum electrodynamics. (auth)

46659 THEORETICAL ANALYSIS OF EXTENSIVE AIR SHOWERS. IV. MUON SHOWERS DEEP UNDERGROUND. Adcock, C. (Univ. of Durham, Eng.); Wolfendale, A. W.; Wdowczyk, J. J. Phys., A (London), 2: 574-83(Sept. 1969).

Studies of muon showers deep underground by the Utah group stimulated an extension of the previous calculations of the present authors into the region covered by the underground experiment: viz. muon threshold energies of the order of 1000 GeV and zenith angles in the region of 60°. The effect of varying some of the more important parameters of the high-energy nucleon–air-nucleus collision was examined, and it is concluded that a multiplicity law of the form $E_p^{\frac{1}{2}}$ is preferred to an $E_p^{\frac{1}{4}}$ law, and that there is no evidence for a significantly greater mean transverse momentum than the value of 0.4 GeV/c, which relates to the parents of muons of lower energy. An increase in the fraction of kaons generated with increasing nucleon energy is not favored. Concerning the mass spectrum of the primary particles, there is some support for the contention that the primaries above 10^{15} eV are largely protons, but none for the conclusion of Grigorov et al., in 1967 that the proportion of heavy nuclei commences to increase at 10^{12} eV.

However, a problem that affects all the conclusions is that significantly fewer multiple events were observed than expected. (auth)

46660 VECTOR-MESON PHOTOPRODUCTION AND THE CLASSIFICATION OF THE POMERANCHUKON. Waltz, R. E. (Univ. of Chicago). Nuovo Cim., 63A: 1-4(Sept. 1, 1969).

It is shown that vector-meson photoproduction is not the most suitable means of distinguishing between the Freund and the CHN classification of the Pomeranchukon. (auth)

46661 THEORY OF FLUCTUATIONS IN AVALANCHES IN A HEAVY SUBSTANCE. Betman, R. G.; Gedalin, E. V. (Inst. of Physics, Tbilisi, USSR). Soobshch. Akad. Nauk Gruz. SSR, 55: 289-92(Aug. 1969). (In Russian).

The method of product density functions, taking into account particle scattering, is used to calculate moments of particle numbers in showers in substances with large Z. It is shown that the calculation of factorial moments of particle numbers is reduced to quadratures. The second and third factorial moments of particle numbers in electromagnetic showers are obtained. (auth)

Weak

46662 SUM RULES FOR THE BARYON MATRIX ELEMENTS OF THE WEAK NON-LEPTONIC HAMILTONIAN. Csikor, F. (Roland Eoetvoes Univ., Budapest). Nucl. Phys., B12: 433-40 (1969).

Sum rules for the baryon matrix elements of the weak non-leptonic Hamiltonian are studied. Some connection between S- and P-wave hyperon decay amplitudes is found. A modified hard-pion method is proposed for the evaluation of the decay matrix elements, which leads to a slightly more favorable comparison with experiment. (auth)

46663 ONCE SUBTRACTED DISPERSION RELATIONS, CURRENT ALGEBRA, AND K_{l4} AXIAL FORM FACTORS. Sebastian, K. J. (Univ. of Maryland, College Park). Nucl. Phys., B12: 471-94(1969).

K_{l4} axial form factors are treated by using once subtracted dispersion relations and current algebra. The subtractions in the dispersion relations are made at the soft-pion limit so that the subtraction constants are given by the Weinberg soft-pion expressions. The dispersion integral is saturated by low-lying "single particle" states, namely the vector mesons and a possible scalar meson nonet. The predicted values for the K_{e4} decay rates seem to be somewhat smaller than the present experimental value. (auth)

46664 ELECTROMAGNETIC CONTRIBUTION TO THE DECAYS $K_S \to l\bar{l}$ AND $K_L \to l\bar{l}$. Sehgal, L. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 183: 1511-13(July 25, 1969).

Using a model in which the decays $K_{S,L} \to l\bar{l}$ occur through a two-photon intermediate state, and considering only the absorptive part of the amplitudes, lower bounds are obtained on the ratios Rate $(K_{S,L} \to l\bar{l})$/Rate$(K_{S,L} \to \gamma\gamma)$. (auth)

46665 APPLICATIONS OF THE ALGEBRA OF CURRENT DENSITIES TO THIRD-ORDER WEAK AMPLITUDES. Lu, Eugene Y. C. (Ohio State Univ., Columbus). Phys. Rev., 183: 1174-82(July 25, 1969).

The techniques developed in previous work for obtaining infinite-momentum sum rules for second-order weak amplitudes from current commutation relations are generalized so that they are applicable to third-order weak amplitudes. Sum rules are then obtained for a particular third-order current matrix element. It is shown that current-algebra sum rules for the corresponding second-order weak amplitudes can be obtained from our sum rules as special cases. On the basis of the sum rules, j-plane analyticity of third-order weak amplitudes is considered; its relation to j-plane analyticity of lower-order weak amplitude is pointed out. The Bjorken limit for third-order weak amplitudes is obtained and applied to discuss the radiative corrections to leptonic decays of pseudoscalar mesons. (auth)

46666 $K^+ \to \pi^+ + \nu + \bar{\nu}$ DECAY IN A NEUTRAL CURRENT CP-NONCONSERVING THEORY. Oakes, R. J. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 183: 1520(July 25, 1969).

The $K^+ \to \pi^+ + \nu + \bar{\nu}$ branching ratio expected in a recently proposed neutral current × current CP-nonconserving weak-interaction theory is estimated to be 1.8×10^{-5}. (auth)

46667 LONG-RANGE CORRECTIONS TO THE COULOMB POTENTIAL AND THEIR IMPLICATIONS ABOUT WEAK INTERACTIONS. Chang, Shau-jin; Rajaraman, R. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 183: 1442-5(July 25, 1969).

Corrections to the photon propagator due to the creation of virtual neutrino pairs are calculated. These are shown to result in long-range ($1/r^3$- and $1/r^5$-type) corrections to the Coulomb potential. It is shown that these corrections are of significance because upper limits on their strengths lead to upper limits on the weak interaction cutoff Λ, and on possible nonconservation of the "μ quantum number." A discussion is given of these upper limits as obtained from the present accuracy of Lamb-shift measurements. (auth)

46668 CURRENT-ALGEBRA MODEL OF $\Delta = 3/2$ EFFECTS IN NONLEPTONIC KAON DECAY. Holstein, Barry R. (Carnegie-Mellon Univ., Pittsburgh). Phys. Rev., 183: 1228-39(July 25, 1969).

A two-parameter semiphenomenological model for nonleptonic kaon decay is constructed under the following assumptions: (i) All single soft-π limits are satisfied; (ii) aside from pole terms, amplitudes can be expanded as a power series in the pion momenta q; and (iii) in particular, in $\langle \pi_q | \mathcal{H}_w | K_k \rangle$ only first- and zeroth-order terms in q are included. The $\Delta I = 1/2$ results are then identical to the recent work of McNamee. Because of the inclusion of q dependence, nonzero $\Delta I = 3/2$ effects are also permitted and are found to be in agreement with the model of Bouchiat and Meyer to order m_π^2/M_K^2. A theoretical estimate of the size of the first-order terms is found to agree with experiment. Uncertainties inherent in our method are discussed.

46669 $K^+ \to \pi^+e^+e^-$ BRANCHING RATIO. Pakvasa, Sandip; Simmons, Walter A. (Univ. of Hawaii, Honolulu). Contract AT(04-3)-511. Phys. Rev., 183: 1215-16(July 25, 1969).

Various theoretical estimates for the branching ratio of the decay mode $K^+ \to \pi^+e^+e^-$ are discussed. Using partial conservation of axial-vector current and current algebra, the process $K^+ \to \pi^+e^+e^-$ is related to $K^+ \to \pi^+\pi^0\gamma$, and a new estimate based on this calculation is presented. It is concluded that the most reliable estimates are close to 10^{-6}. (auth)

46670 VENEZIANO-TYPE AMPLITUDE FOR πK SCATTERING AND THE K_{l3}-DECAY FORM FACTORS. Miyake, Shogo; Akiba, Tomoya (Tohoku Univ., Sendai). Progr. Theor. Phys. (Kyoto), 42: 132-4(July 1969).

The π + K Veneziano-type amplitude predicts possible existence of π + K resonances in the $I = 1/2$, S- and P-wave channels in addition to the well-established K*(0.89 GeV). The $K \to l + \pi + \nu$ decay form factors are examined assuming the existence of these resonances. (W.H.K.)

46671 POLARIZATION PROPERTIES OF β PARTICLES AND THE THIRD-NEUTRINO HYPOTHESIS. Romanov, Yu. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 145-9(Jan. 1969). (In Russian).

Helical properties are not suitable for drawing definitive conclusions because processes involving neutrinos and leptons, not accompanied by changes of primary particles, have not yet been studied. These could be examined on the basis of the elastic and inelastic neutrino (antineutrino)-electron and muon scattering. In inelastic neutrino (antineutrino–lepton scattering events the "charged" lepton currently plays an important role. In the four-component Dirac neutrino theory it was assumed that e^- and μ^+ are leptons and e^+ and μ^- are antileptons; therefore, the μ^+ decay must result in the creation of two antineutrinos (neutrinos) and is attributed to "charged" currents. The true characteristics of the third neutrino may be derived by studying the elastic neutrino–hadron interactions involving all types of neutrinos. The neutrino–nucleus scattering which generates hyperons and the polarization properties of the resulting leptons may allow one to differentiate among hadron, electron, and muon neutrinos. (TTT)

46672 NONLOCAL SUPERPOSITIONS OF K^0, $\bar{K}^0$ AND CP VIOLATION. Achiman, Y. (Tel Aviv Univ., Israel); Horwitz, L. P. Nuovo Cim., 62A: 983-98(Aug. 21, 1969).

It is assumed that K_S, K_L are nonlocal superpositions of K^0 and $\bar{K}^0$, and a possible interpretation of this assumption is discussed. It is found that the form of such a nonlocality is unique, in the first order of its space-time expansion, up to a parameter. Using this form, expressions are found for the measurable quantities in the K_S, K_L decays. In the simplest nontrivial case, $\eta_{00} \approx -2\eta_+$ and $\langle K_S/K_L \rangle = 0$. Consistency with the experimental data, in this case, requires an apparent CPT violation (which may emerge as well from the nonlocal superposition). (auth)

46673 MODELS OF WEAK INTERACTIONS. Segre, G. (Univ. of Pennsylvania, Philadelphia). pp 282-94 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

Various models of weak interactions and the divergence difficulties associated with them are reviewed. A new model mediated by vector bosons is outlined, which removes some of the difficulties. The problem of weak interaction divergences is not solved, but only the order of divergence is reduced by one power for the cases which place the severest limits on the cut-off. (L.B.S.)

46674 CHIRAL SYMMETRY BREAKING, ELECTROMAGNETISM, AND CABIBBO ANGLE. Gatto, Raoul (Istituto di Fisica, Padua). pp 230-56 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

Results are reported of a continuing study of the problem of divergences in the theory of weak interactions within the framework of the simplest quark model. Previous results on the determination of the Cabibbo angle, and the renormalization procedure with an added "predictivity requirement" for the leading divergences are reviewed. The problem of extending the result to all weak orders is considered. It is found that the same type of renormalization as for the quark model can be established in an extension of the field algebra model when passing to a special limit that is called the limit of extended compound field algebra. (L.B.S.)

46675 MODEL FOR WEAK INTERACTIONS. Fronsdal, C.; Norton, R. E. (Univ. of California, Los Angeles). pp 295-303 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

A brief report is given on the status of a model of weak interactions mediated by a scalar meson. (L.B.S.)

46676 WEAK INTERACTION OF PHOTONS AND PHOTO-COULOMB NEUTRINOS. Chaudhuri, Probhas Ray (Indian Statistical Inst., Calcutta). Progr. Theor. Phys. (Kyoto), 42: 116-20(July 1969).

Taking into account that photons can interact weakly with neutrinos, the cross section for the photocoulomb neutrinos $Z + \gamma \rightarrow Z + \nu + \bar{\nu}$ was calculated. From this, the rate of stellar energy loss due to neutrino pair emission was calculated and compared with the result obtained on the basis of the current-current coupling theory. (auth)

46677 ELECTRON–ELECTRON NEUTRINO BREMSSTRAHLUNG. [PART] I. Cazzola, P. (Univ., Ferrara, Italy. Univ., Padua); Saggion, A. Nuovo Cim., 63A: 354-66(Sept. 1, 1969).

The transition probability per unit time and volume relative to processes of the general type $a_1 + a_2 \rightarrow a_3 + a_4 + \nu + \bar{\nu}$ are computed where a_1, a_3 are charged baryons or leptons and a_2, a_4 are leptons, in view of estimating the neutrino energy loss rate in stars due to these processes. A general expression is given for the neutrino energy loss rate in the case of a nondegenerate gas of fermions. (auth)

46678 LEPTON NON-CONSERVATION AND SOLAR NEUTRINOS. Bahcall, J. N.; Frautschi, S. C. (California Inst. of Tech., Pasadena). Contract AT(11-1)-68. Phys. Lett., 29B: 623-5(Aug. 18, 1969).

The consequences for experiments involving solar neutrinos of a small amount of lepton nonconservation are examined following the discussion of Gribov and Pontecorvo. (auth)

46679 ANOTHER RESTRICTION ON WEAK NEUTRAL CURRENTS. Albright, C. H. (Northern Illinois Univ., Dekalb); McGlinn, W. D. Phys. Lett., 29B: 666-8(Aug. 18, 1969).

A restriction on the role of weak neutral currents is derived from a calculation of the Cabibbo angle. Only "universally coupled" neutral V ± A currents of the type encountered in the Schizon model of Lee and Yang appear to satisfy this restriction easily. (auth)

Strong (General)

Refer also to abstracts 45544, 46839, and 46851.

46680 (CALT-68-201) REMARKS ON DIFFRACTION SCATTERING. Zachariasen, F. (California Inst. of Tech., Pasadena). Aug. 1969. Contract AT(11-1)-68. 48p. Dep. CFSTI.

The amplitude for diffraction scattering is discussed. Compatibility with unitarity, calculations of f(t), and partial waves are covered. It is pointed out that there exists no plausible theory of diffraction scattering which starts with unitarity, crossing, and analyticity and proceeds to a differential cross section. (J.F.P.)

46681 (UCRL-19205) MODELS FOR HIGH ENERGY PROCESSES. Jackson, J. D. (California Univ., Berkeley. Lawrence Radiation Lab.). May 19, 1969. Contract W-7405-eng-48. 188p. (CONF-690608-8). Dep. CFSTI.

From International Conference on Elementary Particles, Lund, Sweden.

A review is presented of a model for high-energy processes. Topics include recent data from hadron interactions, Regge pole models, optical models and Regge cuts for multiple scattering, finite-energy sum rules and duality, Veneziano models, multiperipheralism, and production processes. (J.F.P.)

46682 MODEL FOR THE HADRONS. Mandula, Jeffrey; Weyers, Jacques; Zweig, George (California Inst. of Tech., Pasadena). Phys. Rev. Lett., 23: 627-8(Sept. 15, 1969).

A particle spectrum is obtained from duality. (auth)

46683 TWICE-SUBTRACTED DISPERSION RELATION FROM THE LOW EQUATION AT INFINITE MOMENTUM. Poe, R. F. (Univ. of California, San Diego, La Jolla). Phys. Rev., 183: 1216-21(July 25, 1969).

The role of "seagull" terms in the Low equation is investigated in the limit of infinite momentum. It is found that these terms provide two (and only two) subtractions to the resulting dispersion relation. (auth)

46684 DIFFICULTIES IN SPIN TREATMENTS IN THE QUARK MODEL FOR HIGH-ENERGY SCATTERING. Lipkin, Harry J. (Weizmann Inst. of Science, Rehovoth, Israel). Contract F-61052-68-C-0070. Phys. Rev., 183: 1221-7(July 25, 1969).

The nonrelativistic quark-model treatment of hadron scattering is shown to be inconsistent at relativistic momentum transfers. The validity of predictions is examined. Difficulties arise in the specification of the spin orientations and couplings of spectator quarks whose states are "unchanged" in the scattering process, but which undergo Wigner rotations in the transformation between the rest frames of the initial and final states. The small relativistic "tail" of the mainly nonrelativistic bound-state wave function is also shown to play an important role in relativistic scattering processes. A consistent formulation with spin form factors is developed and applied to determine which of the nonrelativistic predictions are still valid at relativistic velocities, and which break down. (auth)

46685 SIMULATED EXTENSIVE AIR SHOWERS WITH A MEDIUM-STRONG INTERACTION. Campbell, J. A. (Univ. of Texas, Austin). Phys. Rev., 183: 1111-15(July 25, 1969).

It is proposed that anomalous measurements of cosmic-ray pions and muons above a characteristic energy of 10^{12} eV can be explained, at least in part, by the presence of the medium-strong contact interaction between protons. That has been suggested by Abarbanel, Drell, and Gilman. The results of a programmed simulation of extensive air showers in a simple model have the correct behavior to explain the pion measurements, and they show a slight tendency in the correct direction for an explanation of the measurements of muons. Some remarks are made on the difficulties associated with theories of direct production of muons. (auth)

46686 REMARKS ON THE KINEMATICS OF MULTIPERIPHERAL PROCESSES. Chang, Shau-jin; Rajaraman, R. (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 183: 1517-19(July 25, 1969).

The implications of requiring that the "subenergies" s_i and the momentum transfers t_i of a multiple production process be in the Regge domain are studied. It is shown that even for very high-energy accelerator or cosmic-ray processes, the s_i are too small compared to the t_i and the masses for one to apply a multi-Regge formalism for the two-particle → n-particle amplitude. Some alternatives are suggested. (auth)

46687 POSSIBLE BORN TERM FOR THE HADRON BOOTSTRAP. Bardakci, K.; Halpern, M. B. (Univ. of California, Berkeley). Phys. Rev., 183: 1456-62(July 25, 1969).

From the set of all quark scattering functions in the Veneziano model, a completely factored, Reggeized, and crossing-symmetric set of hadron n-point functions is projected out with spin and internal symmetry. (auth)

46688 DUALITY AND REARRANGEMENT OF SAKATON. Matsuoka, Takeo; Ninomiya, Kansuke; Sawada, Shoji (Nagoya Univ., Japan). Progr. Theor. Phys. (Kyoto), 42: 56-67(July 1969).

From the viewpoint of the rearrangement of sakaton, dual properties between the s-, t- and u-channel scattering amplitudes of various two-body processes are investigated. The correspondence of the rearrangement diagrams to the amplitudes at both high and low energies given by the Regge pole model, Veneziano model and one-boson-exchange model is discussed. (auth)

46689 BOOTSTRAPS, FINITE ENERGY SUM RULES, AND CLOSED FORMS FOR THE SCATTERING AMPLITUDES. Rubinstein, H. (New York Univ.). pp 362-78 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

The problem of bootstrap conditions and closed amplitudes is first discussed. A new method for treating hadron decay is presented, which is a generalization of the idea of Lovelace and provides for a new way to parametrize the amplitudes. This method is then applied to the study of $N\bar{N}$ annihilations into three pions. Another example, the E meson, is studied that is well described by this method. Finally the limitations of this method and some other consequences of durality are discussed. (L.B.S.)

46690 RELATIVISTIC QUASIPOTENTIAL MODEL OF PARTICLE SCATTERING AT HIGH ENERGIES. Garsevanishvili, V. R.; Matveev, V. A.; Slepchenko, L. A.; Tavhelidze, A. N. (Joint Inst. for Nuclear Research, Dubna, USSR). pp 74-82 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

The high-energy elastic scattering amplitude of two spinless particles of unequal mass is studied on the basis of a quasipotential equation. The quasipotential of the simplest Gaussian type is used. (L.B.S.)

46691 MULTIPERIPHERAL DYNAMICS. Goldberger, M. L. (Princeton Univ., N. J.). pp 142-56 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

The possibility is explored of making a realistic dynamics of strongly interacting systems, which takes into account the fact that unitarity inevitably couples multiparticle channels to the two-particle amplitudes. (L.B.S.)

46692 SIMPLE RELATIVISTIC MODELS OF THE HADRONS. Blokhinstev, D. (Joint Inst. of Nuclear Research, Dubna, USSR). pp 69-73 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

A short report is given of some simple relativistic models of the hadrons and their interactions. These include the relativistic rotator model, harmonic oscillator model with spin-orbital coupling, optical model, and the quasipotential method. (L.B.S.)

46693 CROSSING SYMMETRIC REGGE BEHAVIOR AND THE IDEA OF DUALITY. Veneziano, G. (Massachusetts Inst. of Tech., Cambridge). pp 113-41 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

A brief review is given of some results that have come out during the last few months on the relationship between crossing symmetry and Regge behavior in S-matrix theory. These results are considered as the starting point of a more ambitious program containing a possible new formulation of the bootstrap idea. The 1961 formulation of the bootstrap idea in terms of Regge theory is briefly recalled. A possible way is presented of implementing it in a two step program suggested by some concepts recently developed during attempts to understand the dynamics of strong interactions. A new justification of the solution proposed for the two body scattering amplitude is presented. The relevant properties of this crossing symmetric formula are discussed. A few experimental tests and the most significant new developments are considered in some detail. A possible approach to the second part of this bootstrap program is briefly considered. (auth)

46694 SELF-CONSISTENCY IN THE DYNAMICS OF STRONG INTERACTIONS. Chiu, Charles B.; Eden, Richard J.; Green, Michael B. (Cambridge Univ., Eng.). pp 98-112 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

Some results are given of a general method for constructing a collision amplitude F(s,t) that is consistent with analyticity, crossing, and asymptotic behavior. The general method is based on the study of surfaces of zeros of the collision amplitude by means of phase contours. The following topics and results are discussed: phase contours, zeros, and resonances for a symmetric amplitude; zeros in a narrow resonance approximation; the unitarity hypothesis and the linear bootstrap condition; the relation to the Veneziano model; the effects of higher spins of the external particles; effects of mixed symmetries; and applications and experimental comparison of the constraints on the Regge trajectories. (L.B.S.)

46695 SUMMARY OF THE STATUS OF THE l-EXCITATION QUARK MODEL OF MESON AND BARYON RESONANCES. Feld, B. T. (Massachusetts Inst. of Tech., Cambridge). pp 157-80 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

A brief discussion is given on the status of l-excited mesonic and baryonic states and generalized Regge trajectories for higher baryonic states. Tables are included on the following: even parity mesonic states; meson mass relations for l-excited multiplets; values for the (t = 1, y = 0) members of the R-meson (l = 2) supermultiplet; main decay modes of R(l = 2) mesons; proposed spectrum of baryons in the L = 1, 70^- qqq supermultiplet; and SU(3) mass constants for perturbed octets within the 70^- (L = 1) supermultiplet. In addition, plots of mesonic and baryon spectra and of generalized Regge trajectories are included. (L.B.S.)

46696 ROLE OF HADRON ALGEBRAS. Ne'eman, Y. (Tel-Aviv Univ., Israel). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 107-18(1968).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

The discussion of the role of hadron algebras covers the conceptual evolution of the algebraic method, a generalized Poincaré group, the experimental verification of the compactness of current algebra, the approximate symmetries, spectrum-generating algebras, and transition operators algebras. (J.F.P.)

46697 PRESENT STATUS OF THE PHENOMENOLOGICAL REGGE POLE THEORY. I. Bando, Masako; Morita, Katsusada (Kyoto Univ.). Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem., 33: 11-54(Oct. 1968).

A systematic review of recent developments in phenomenological Regge pole theory of high energy scattering is presented. (auth)

Strong (Baryon No. = 0)

Refer also to abstracts 46670 and 46801.

46698 (JINR-P2-4375) $K\pi$ INTERACTION AT LOW ENERGIES. Isaev, P. S. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 20p. (In Russian). Dep. CFSTI (U.S. Sales Only).

Dispersion relations for s- and p-waves of $K\pi$-scattering were obtained with the account of the short-wave repulsion according to the Shirkov–Serebryakov method. The solutions for the partial waves are constructed in accordance with the available data on $K\pi$-interaction. If there exists a κ-meson with a mass of about 1100 MeV and quantum numbers $Jp = 0^+$, its width is predicted to be ≈350–400 MeV. The boundary of applicability of static approximation is estimated. (auth)

46699 (NP–18000) ON THE SCATTERING AMPLITUDE $A(\bar{p}n \to 3\pi)$. Note No. 221. Boldrighini, C.; Publiese, A. (Rome

Univ. (Italy). Istituto di Fisica). May 5, 1969. 10p. Dep. CFSTI (U.S. Sales Only.)

The phenomenological validity of the simple amplitude for the case of a trajectory having a real and an imaginary part is investigated for the process $\bar{p} + n \rightarrow 3\pi$. It is pointed out that the observed discrepancy with the data reflects the insufficiency of this amplitude (previously mentioned); that is, the lack of higher thresholds. (J.F.P.)

46700 UNIVERSAL ρ COUPLING AND THE ADLER–WEISBERGER THEOREM FOR $\pi^-\rho^+$ AND $\pi^-A_1^+$ IN THE VENEZIANO MODEL. McKay, Douglas W.; Wada, Walter W. (Ohio State Univ., Columbus). Phys. Rev. Lett., 23: 619-23(Sept. 15, 1969).

Minimal Veneziano representations, normalized to the t-channel ρ poles, are written for the $\pi^-\rho^+ \rightarrow \pi^-\rho^+$ and $\pi^-A_1^+ \rightarrow \pi^-A_1^+$ invariant amplitudes relevant to the Adler–Weisberger theorem. Using these amplitudes and the results of other authors for $\pi^-\pi^+$ and π^-K^+, it is found that the Adler–Weisberger theorem is satisfied for $\pi^-\pi^+$, π^-K^+, $\pi^-\rho^+$, and $\pi^-A_1^+$ elastic scattering if the $\rho\pi\pi$, ρKK, $\rho\rho\rho$, and ρAA charge couplings all have the same (universal) value. (auth)

46701 DALITZ-PLOT ANALYSIS INCLUDING DUALITY. Altarelli, Guido; Rubinstein, Hector R. (New York Univ., N. Y.). Phys. Rev., 183: 1469-71(July 25, 1969).

Using fairly general parametrizations of the Veneziano type for the decay amplitude, the annihilations of $\bar{N}N$ at rest (in the T = 1 channel) into three pions are studied. Very good agreement is obtained for the well-known $\bar{p}n$ channel in terms of four essential parameters. A previous model due to Lovelace is found to be inaccurate in fitting the data, and therefore his phenomenological interpretation is changed. If the predictions for other decay channels are confirmed, the generally accepted decoupling of the ρ in $\bar{N}N$ (T = 1) is probably incorrect. It is suggested that this procedure is the right one for parametrizing decay amplitudes in order to check if duality is a true property of strong interactions. (auth)

46702 J-PLANE STRUCTURE OF THE VENEZIANO MODEL. Fivel, D. I.; Mitter, P. K. (Univ. of Maryland, College Park). Phys. Rev., 183: 1240-5(July 25, 1969).

The Veneziano model for $\pi^+\pi^-$ elastic scattering is subjected to J-plane analysis, and it is shown in that in the finite J plane it consists only of Regge poles and fixed poles at nonsense wrong-signature points. The residues of the leading and first two subsidiary trajectories are computed explicitly, and an algorithm is derived for the computation of all others. In deriving the algorithm, the Mandelstam form of the Regge-pole series is obtained. It is shown that this series is asymptotic in a certain domain, but not convergent, thus demonstrating the essential role of the background integration in producing crossing symmetry. The relation between the Veneziano residues and those of the Khuri model is discussed, as well as some other features of the J-plane structure. (auth)

46703 DUALITY AND CROSSING SYMMETRY OF THE VENEZIANO MODEL. Kiang, D. (Dalhousie Univ., Halifax, Novia Scotia); Nakazawa, K.; Ross, W. Nuovo Cim., Lett., 2: 203-6(Aug. 11, 1969).

It was previously shown in connection with strong duality that the Veneziano amplitude could be split into two terms. It is shown that this splitting is nothing else than the decomposition into the Regge-pole term and the background term required by crossing symmetry including the correct signature factors. It is also shown that the Veneziano amplitude has the same structure as the interference model. It is concluded that such crossing-symmetric models are not compatible with strong duality in the usual sense. (L.B.S.)

46704 s- AND p-WAVE $\pi-\pi$ PHASE SHIFTS AT LOW ENERGIES. Gore, Bryan F. (Univ. of Michigan, Ann Arbor). Phys. Rev., 183: 1431-8(July 25, 1969).

The Lorentz-invariant $\pi-\pi$ scattering amplitude is investigated on the basis of the analyticity and unitarity of the S matrix. The assumptions of elastic unitarity and approximate crossing symmetry allow the calculation of subtracted dispersion integrals for s and p partial waves. Of the seven parameters introduced, five are fixed by derivative conditions to third order from crossing symmetry, and the others by the requirement that the p-wave solution exhibit a resonance of mass 750 MeV and width 110 MeV. The computations were iterated by computer. Five different parametrizations are investigated; nine solutions are found, belonging to three parametrizations. Six of the solutions belong to one parametrization; the others are similar. Various model calculations reported in the literature yield solutions similar to ours, but no model has produced our complete spectrum. A "best" solution is selected on the basis of self-consistency and lack of nearby physical-sheet poles of the scattering amplitude. It is characterized by s-wave phase shifts dropping from threshold. The phase-shift decreases at the ρ-meson mass are $(72 \pm 3)^\circ$ for I = 0 and $(41 \pm 4)^\circ$ for I = 2. The p-wave phase shift is similar to that of a Breit-Wigner resonance, but does not approach 180° as rapidly. The scattering lengths are $\mu\alpha_0^0 = -0.69 \pm 0.04$, $\mu\alpha_0^2 = -0.37 \pm 0.03$, and $\mu^3\alpha_1^1 = 0.028$. (auth)

46705 VENEZIANO REPRESENTATION AND THE BOSON SPECTRUM. Wong, David Y. (Univ. of California, San Diego, La Jolla). Phys. Rev., 183: 1412-15(July 25, 1969).

The Veneziano representation for the scattering of two pseudoscalar mesons is constructed under the assumptions of (1) linear trajectories with identical slopes, (2) Adler conditions for soft K as well as for soft π, (3) no $I \geq 3/2$ or $S \geq 2$ direct-channel resonances, and (4) no nonleading terms in the Veneziano representation. It is found that a nonet of vector-tensor trajectories is consistent with the above assumptions, while a pure octet is not. The ω-φ and the f^0-f' mixing angles are predicted to be given by $\sin\theta = 1/\sqrt{3}$. The Adler conditions lead to the requirements that the ω, ρ, f^0, and A_2 mesons lie on a degenerate trajectory $1/2$ unit above the π, that the K^*-K_B trajectory lie $1/2$ unit above the K, and that an A_2' trajectory with only even-J members appear $1/2$ unit above the η. The Adler conditions also give the Okubo mass formula for the φ and f' mesons, and the Gell-Mann–Okubo formula for the η. The possibility of the splitting of f' into two peaks is also discussed. In this model, the residues of leading poles satisfy factorization, while the daughter poles manifestly violate factorization. Since unitarity implies factorization, it is argued that the daughters must be significantly modified by any unitarization procedure, but the leading poles can be interpreted as resonances in the usual way. The lack of simple algebraic relations among the residues of daughter poles also suggests that the daughters need not belong to SU_3 multiplets. The J = 1 recurrences of the pseudoscalar mesons are identified as the axial vectors A, K_A, and D(1285). The B meson, however, seems to fit well as a daughter of the ρ, and hence need not belong to an SU_3 multiplet. (auth)

46706 UPPER AND LOWER BOUNDS ON THE $\pi^0\pi^0 \rightarrow \pi^0\pi^0$ PARTIAL-WAVE AMPLITUDES BELOW THRESHOLD. Roy, S. M. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 183: 1403-6(July 25, 1969).

Rigorous upper and lower bounds on the $\pi^0\pi^0 \rightarrow \pi^0\pi^0$ partial-wave amplitudes $\alpha_l(s)$, involving only the pion mass, are obtained for l = 0, 2, 4, . . ., and s positive and below threshold. (auth)

46707 COUPLED DYNAMICAL EQUATIONS INCORPORATING UNITARITY AND CROSSING. I. $\pi\pi$ AND πK SCATTERING Humble, Stephen (Univ. of Colorado, Boulder). Phys. Rev., 183: 1335-44(July 25, 1969).

An equation proposed by Zimmermann, which takes account of the normal thresholds in s, t, and u channels, is generalized to two-body reactions involving particles of any spin or isospin, and extended to include a number of coupled processes in each channel. In this form, the resulting equations, besides satisfying the requirements of low-energy unitarity and crossing symmetry, take some account of the effect of all reactions in each channel, as well as the detailed energy-dependent effects of one or two low-mass processes. The coupled $\pi\pi$ and πK system is considered, and approximate solutions are found which give the ρ and K* resonance parameters within 15% of the accepted experimental values, as well as a κ resonance in the $I = 1/2$ s-wave πK partial wave. The $\pi\pi$ s-wave phase shifts in this case are found to be very negative, decreasing rapidly to $-\pi$; but with the coupling of the $\pi\pi \rightarrow \pi\omega$ reaction to this system; a solution is obtained giving an I = 0, $\pi\pi$ s-wave which, at low energies, is in agreement with some recent phenomenological analyses. (auth)

46708 EQUAL-TIME COMMUTATORS AND LOW-ENERGY $\pi-\pi$ SCATTERING. Carbone, G.; Donini, E.; Sciuto, S. (Univ., Turin). Nuovo Cim., 62A: 961-71(Aug. 21, 1969).

An extension of the theory of low-energy s-wave $\pi\pi$ scattering to higher waves is discussed. By assuming the simplest commutation relations of field algebra, sum rules are obtained where only the s- and p-wave contributions are allowed; these ones are evaluated by means of the σ and ρ resonant states. On the basis of some further hypotheses on the behavior of the $\sigma\pi\pi$ and $\rho\pi\pi$ off-mass-shell form factors, the p-wave scattering length is estimated. (auth)

46709 VENEZIANO-TYPE FORM FACTORS FOR THE PION. Suura, H. (Univ. of Minnesota, Minneapolis). Phys. Rev. Lett., 23: 551-4(Sept. 8, 1969).

The scalar, pseudoscalar, vector, and axial-vector form factors

of the pion are derived from (i) the Veneziano amplitudes for $\pi^+\pi^- \to \pi^+\pi^-$ and $\pi^+\pi^- \to A_1^+\pi^-$, (ii) the hypothesis of the partially conserved axial-vector current, and (iii) the requirement that a chirally conjugate pair of form factors should exhibit similar structures. The resulting form factors feature an infinite sequence of poles corresponding to daughters of specific spin and parity, and definite signature. Various predictions on the clashing-beam production of 2π and on ρ-meson coupling constants are given. (auth)

46710 CROSSING CONDITIONS FOR THE PION–PION AMPLITUDE. Martin, A. (CERN, Geneva). Nuovo Cim., 63A: 167-80(Sept. 1, 1969).

A denumerable set of rigorous inequalities is obtained on the $\pi^0\pi^0 \to \pi^0\pi^0$ partial-wave amplitudes which guarantee that the amplitude is crossing symmetric. The numerical inequalities presented for the case of S and D waves indicate that one has very little freedom in the choice of the D-waves once the S-waves are given. (auth)

46711 FACTORIZATION AND DEGENERACY OF THE HADRON SPECTRUM IN THE VENEZIANO MODEL. Cassandro, M. (Univ., Rome. Istituto Nazionale di Fisica Nucleare, Rome); Maiani, L. Nuovo Cim., Lett., 2: 279-83(Aug. 21, 1969).

The factorization properties of the Veneziano amplitude are studied for two-body scattering of spinless particles. Factorization is imposed on the residues of the poles in the s channel, and the amplitudes of $\pi^+ + \pi^- \to \pi^+ + \pi^-$, $K^+ + K^- \to K^+ + K^-$ interactions are studied. The scattering of scalar particles and particles belonging to different SU(3) multiplets is considered. It is found that factorization and positivity are not in contrast with the Veneziano amplitude for two-body spinless scattering only if one allows for a degenerate pattern of resonances. The degenerate structure does not show up in the scattering of particles belonging to the same SU(3) multiplet up to second order in SU(3) breaking, and this could be related to a nonrenormalization theorem for the relevant coupling constants. (J.F.P.)

46712 GENERALIZATION OF THE CONCEPT OF SIGNATURE AND THE ASYMPTOTIC PROPERTIES OF THE AMPLITUDE OF $(\pi-\pi)$-SCATTERING. Volkov, D. V.; Gur'ev, V. N. (Physical Technical Inst., Kharkov). Ukr. Fiz. Zh., 14: 862-5 (May 1969). (In Russian).

In considering the asymptotic properties of the amplitude of particle scattering at high energies, a widely used approach is based on the use of complex angular momentum (Regge poles). The concept of signature is associated with symmetrization of the scattering amplitude with respect to replacement of $\cos\theta$ by $-\cos\theta$. Since each Regge pole has a definite signature, the amplitude has a definite symmetry with respect to the above rearrangement with the assumption of a dominating contribution of one pole in the asymptotic region. This assumption is used to obtain ratios between amplitudes with different quantum numbers in $(\pi-\pi)$-scattering. The ratios of $(\pi-\pi)$-scattering in definite charge states is also considered on the hypothesis that the main contribution to the amplitude is given by a function with definite properties of symmetry with respect to transpositions of all three variables. An analogous scheme of generalizing the concept of signature can be presented for the scattering amplitude which takes into account other internal quantum numbers. This problem will be considered later for nucleon-nucleon scattering. An analogous approach can also be investigated for SU(3)-variables. (TTT)

46713 ON THE $\eta \to 3\pi$ DECAY. Yamazaki, Toshio; Kitazoe, Tetsuro (Osaka Univ. Kobe Univ., Japan). Progr. Theor. Phys. (Kyoto), 42: 141-3 (July 1969).

The η-π^0 effective coupling constant $f_{\eta\pi}$ is calculated on the basis of the meson pole dominance model, using current algebra techniques. The result is used to obtain for the absolute decay rate of $\eta \to 3\pi^0$ $\Gamma \approx 0.78$ keV, which is in fair agreement with experiment. (L.B.S.)

46714 A GENERAL TREATMENT OF FACTORIZATION IN DUAL RESONANCE MODELS. Fubini, S.; Gordon, D.; Veneziano, G. (Massachusetts Inst. of Tech., Cambridge). Contract AT-(30-1)-2098. Phys. Lett., 29B: 679-82(Aug. 18, 1969).

A formalism is provided for the treatment of dual amplitude structure. This formalism allows the general n-point function to be expressed as a factorized product of vertices and propagators. Interest in dual resonance models given general expressions for the interaction of an arbitrary number of spinless bosons is noted. (J.F.P.)

46715 DUALITY-PRESERVING REGGE CUTS. Barger, V. (Univ. of Wisconsin, Madison); Phillips, R. J. N. Contract (11-1)-881. Phys. Lett., 29B: 676-8(Aug. 18, 1969).

The duality of resonances with Regge exchanges is examined in the presence of Regge cuts. It is pointed out that multiple scattering prescriptions for the leading cut corrections to Regge poles preserve this duality and its powerful null conditions. If the poles are nonexotic and exchange-degenerate, so also are the Pomeron-generated cuts. Other lower lying cuts do not share these properties. Interesting consequences of retaining only the duality-preserving cuts are remarked. (auth)

46716 HARD-PION EFFECTIVE-RANGE FORMULA FOR THE PION FORM FACTOR. Brehm, J. J.; Golowich, E.; Prasad, S. C. (Univ. of Massachusetts, Amherst). Phys. Rev. Lett., 23: 666-70(Sept. 22, 1969).

Using chiral SU(2) current algebra and partially conserved axial-vector current to generate a set of Ward identities a relation was derived which can be interpreted as a dynamical equation for the off-shell pion form factor. The equation is solved on shell in an effective-range approximation for the pion form factor, and from unitarity the p-wave $\pi\pi$ phase shift is deduced. The results are in excellent agreement with all relevant data. (auth)

46717 PHENOMENOLOGICAL LAGRANGIAN METHOD FOR CHIRAL SYMMETRIES. Barnhart, Lloyd Patterson. New York, New York Univ., 1968. 82p.

Thesis.

A description is given of several phenomenological models of the hadrons that are used to derive consequences of the algebra of chiral SU(2) × SU(2) and chiral SU(3) × SU(3) obeyed by conserved vector and partially conserved axial-vector currents. The first of these consists of a Lagrangian involving only nucleons and pions that is invariant, except for the pion mass term, under SU(2) × SU(2). It is derived in two ways: first, as a chiral transform of a modified form of the σ-model; second, by specifying that the nucleon and pion fields transform under a particular nonlinear realization of SU(2) × SU(2) and constructing a Lagrangian invariant under the group. The Lagrangian is phenomenological in the sense that processes are calculated by taking only the lowest-order graphs in which they occur. The second model adds vector and axial-vector mesons and is also gotten in two ways: first, by introducing Yang–Mills fields into the σ-model before transforming; second, by specifying appropriate nonlinear transformation properties for the vector and axial-vector mesons also. Vector dominance is required of this model, which immediately gives Weinberg's mass formula for the axial-vector meson. With the low-energy s- and p-wave pion-nucleon coupling constants as inputs, one obtains immediately from the first model the Adler-Weisberger and Goldberger-Treiman relations and Adler's consistency theorems for pion-pion and pion-nucleon scattering. By adjusting one of the remaining free coupling constants in the second model, reasonable rates for the decays of the rho meson into two pions and the A_1 meson into a rho meson and a pion are obtained. Also the equivalence of the first and second models in the limit of large masses of the vector mesons is illustrated for processes involving pions and nucleons. The third and fourth models described are the generalization of the first and second to SU(3) × SU(3) and involve quarks and meson octets. Also briefly sketched is a fifth model involving the baryon and pseudoscalar meson octets. (Diss. Abstr.)

46718 SOFT-PHOTON EMISSION APPROACH TO THE DECAYS $\omega, \varphi, \rho, \to 2\pi\gamma$. Pascual, R. (Univ., Madrid); Srivastava, Prem P. Notas Fis., Cent. Brasil. Pesqui. Fis., 14: No. 5 217-24(1968).

The hypothesis of PCTC for the electromagnetic current is used to calculate the rates of the decays $\omega, \varphi \to 2\pi\gamma$ and $\rho \to 2\pi\gamma$. (auth)

Strong (Baryon No. = 1)

Refer also to abstracts 46643, 46809, and 46849.

46719 (JINR-P2-4524) ANGULAR DISTRIBUTION IN THE REACTION $\pi^- + p \to e^+ + e^- + n$. Surovtsev, Yu. S.; Tkebuchava, F. G. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 6p. (In Russian). Dep. CFSTI (U.S. Sales Only).

The angular distribution in the reaction $\pi^-p \to e^+e^-n$ is considered on the basis of the previously performed general analysis of the matrix element structure of the process $\pi N \to N\gamma$ (virtual). (auth)

46720 (JINR-P2-4535) INVESTIGATION OF THE FIRST BARYON RESONANCE BY THE METHOD OF ANALYTIC CONTINUATION INTO UNPHYSICAL REGION OF THE πN SCATTER-

ING PARTIAL AMPLITUDE. Markovski, B. L.; Nedyalkov, I. P. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 15p. (In Russian). Dep. CFSTI (U.S. Sales Only).

The method of analytic continuation of the partial amplitude on the unphysical sheet, proposed some time ago is applied to the investigation of the resonances which appear in the πN system at $J = I = 3/2$. Some information about the existence of the resonances with masses 1612 and 1688 MeV in addition to Δ_{33} is obtained. (auth)

46721 COMPARISON OF $\overline{pp}$ ANNIHILATIONS AND πp AND Kp BACKWARD ELASTIC SCATTERING USING CROSSING RELATIONS. Barish, B. C. (California Inst. of Tech., Pasadena); Nicholson, H.; Pine, J.; (and others). Phys. Rev. Lett., 23: 607-10(Sept. 15, 1969).

In a recent series of experiments, π^+p and K^+p backward scattering and $\overline{pp}$ annihilations into $\pi^+\pi^-$ and K^+K^- in the forward-backward direction were measured. These data are compared assuming the dominance of a baryon-exchange amplitude and the validity of the crossing-symmetry relations. (auth)

46722 REGGE FITS WITH VENEZIANO RESIDUES. Lovelace, C. (CERN, Geneva). Nucl. Phys., B12: 253-73(1969).

It is explored how the Regge limit of the Veneziano formula works experimentally. Absorptive cuts are essential. The resulting fit to πN, KN and $\overline{K}N$ has fewer parameters than any previous Regge fit. Though not perfect, it is argued that discrepancies come from the lowest partial waves where absorptive models are not quantitatively reliable. This leads to a scheme for Reggeized phase shift analysis. (auth)

46723 LOW-ENERGY RELATIONS FOR ON-SHELL πN SCATTERING. Radescu, E. E. (Inst. of Atomic Physics, Bucharest). Nucl. Phys., B12: 395-409(1969).

Using the Fubini–Furlan mass extrapolation procedure, a low-energy theorem is derived and analyzed for the on-shell πN collision, involving the p-wave scattering length combination $a_{1+}^{(-)} - a_{1+}^{(-)}$ (the superscript (-) denotes the isospin odd configuration and the subscript 1 the value of the orbital angular momentum l). It is pointed out that in the above particular combination, in the framework of the hypothesis on the asymptotic behavior of a certain weak amplitude, the corrections to the soft-pion result might be completely negligible. Finally, a simple evaluation (which seems to work rather well) is given of the model-dependent weak amplitude appearing in the sum rule, by using different theoretical determinations of the axial-vector, nucleon, $N^*(3/2,3/2)$-resonance coupling constant. (auth)

46724 LOW-ENERGY $\overline{K}N$ AND PION–HYPERON INTERACTIONS. I. K-MATRIX ANALYSIS OF K^-p REACTIONS. Martin, B. R.; Sakitt, M. (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 183: 1345-51(July 25, 1969).

A nine-parameter K-matrix formalism for the low-energy K^-p interaction is described. These parameters are then determined by fitting the existing experimental data. A good fit is obtained to the data, and some properties of the solution are discussed. (auth)

46725 LOW-ENERGY $\overline{K}N$ AND PION–HYPERON INTERACTIONS. II. APPLICATIONS OF THE K-MATRIX ANALYSIS. Martin, B. R. (University Coll., London); Sakitt, M. Phys. Rev., 183: 1352-8(July 25, 1969).

s-wave K-matrix parameters deduced from a previous analysis of K^-p data are used to obtain the scattering lengths and low-energy behavior of the s-wave $\overline{K}N$, $\pi\Lambda$, and $\pi\Sigma$ amplitudes. In addition, an application involving the use of KN forward-dispersion-relation sum rules to calculate values for the $K\Lambda N$ and $K\Sigma N$ coupling constants is given. It is shown that present ambiguities in the evaluation of the unphysical regions of these sum rules prevent a reliable calculation of the coupling constants being made at this time. It is concluded that $3 \lesssim g^2_{K\Lambda p}/4\pi \lesssim 15$ and $g^2_{K\Sigma^+p}/4\pi \lesssim 2.1$. (auth)

46726 RELATIONSHIP OF EXCHANGE DEGENERACY, THE FINITE-ENERGY SUM RULE, AND TOTAL CROSS SECTIONS. Graham, R. H.; Logan, R. K. (Univ. of Toronto). Phys. Rev., 183: 1440-1(July 25, 1969).

It is shown that exchange degeneracy explains why total cross sections which are flat at low energies remain flat at high energies. It is also shown that exchange degeneracy can lead to Harari's specialized form of the finite-energy sum rule in certain cases. (auth)

46727 PREDICTIONS OF A NEW INTERFERENCE MODEL FOR NEAR-FORWARD PION–NUCLEON SCATTERING. Johnson, Robert C. (Univ. of Toronto). Phys. Rev., 183: 1406-11 (July 25, 1969).

Using parameters determined by outside means, the predictions are discussed for small-angle pion-nucleon scattering below 2 GeV/c of the interference model that equates the background to the Pomeranchon exchange amplitude. The quantitative predictions for elastic scattering are rather poor, but the moderate success of the direct-channel resonances alone in predicting the charge-exchange process leads to a suggestion for the determination of resonance parameters in phase-shift analysis, and to a reinterpretation of the model which has several interesting features. (auth)

46728 DISPERSION SUM RULES FOR THE NONSTRANGE BARYON SPECTRUM. Frampton, P. H.; Hamprecht, B. (Univ. of Chicago). Phys. Rev., 183: 1416-24(July 25, 1969).

A study is made of the saturation of superconvergence relations by the known N (isospin-1/2) and Δ (isospin-3/2) nonstrange baryon resonances. Account is taken of the shape of the strong-interaction form factors as well as of the magnitude of the coupling constants. At a $\pi\Delta(1236)$ vertex, there are two independent form factors (spin component 1/2 and 3/2), and at a πN (nucleon) vertex, only one. Making a physically plausible assumption about the smoothness of these form-factor functions, a detailed study is made of sum rules in $\pi\Delta \to \pi\Delta$ and $\pi N \to \pi\Delta$ scattering. Two especially interesting relations occur in the elastic process $\pi\Delta \to \pi\Delta$, one relation involving only the N spectrum, the other only the Δ spectrum. The sum rule for the N spectrum is not saturated by the set of states which we insert, and this leads to the conjecture that there exists a spin-3/2 $\pi\Delta$ resonance which is at quite low mass and which is not reported in the πN phase-shift analysis. A possible fit to a larger set of sum rules is then considered; the fit is consistent with linear Regge trajectories and provides a starting point for a detailed check when better partial-width data are available. (auth)

46729 CHARGE INDEPENDENCE IN Σ HYPERON PRODUCTION. Binford, Thomas O.; Good, Myron L.; Kofler, Richard R. (Univ. of Wisconsin, Madison). Contract AT(11-1)-881. Phys. Rev., 183: 1148-51(July 25, 1969).

The triangle inequality of charge independence is evaluated with the data of the preceding papers on the reactions $\pi N \to \Sigma K$. In the small-momentum-transfer region, the inequality is satisfied by the data only after allowing for experimental errors. Thus, the fit lies at the edge of the region allowed by charge independence. (auth)

46730 VIRTUAL DIFFRACTION AND THE REACTION $K^-p \to \overline{K}^{*0}\pi^-p$. II. Schonfelder, J. L. (Imperial Coll. of Science and Tech., London. Univ. of Birmingham, Eng.); Hunt, A. P. Nuovo Cim., 62A: 820-8(Aug. 21, 1969).

Detailed calculations of the "Deck" virtual diffraction background plus possible coherent diffractively produced resonances and the incoherent K_N^* resonance are presented at 6 and 10 GeV/c for the reaction $K^-p \to \overline{K}^{*0}\pi^-p$. "Off-shell" and "absorption" effects were allowed for by the inclusion of phenomenological form factors. A simple parametrization for the diffractive production of the resonances in the $K^*\pi$ enhancement is employed and these amplitudes, which include the subsequent decay, interfere with the "Deck" background. A reasonable fit to experiment is obtained. (auth)

46731 VECTOR-MESON INTERACTION HAMILTONIAN. Kyriakopoulos, E. (Univ. of Chicago). Phys. Rev., 183: 1318-23(July 25, 1969).

The vector mesons are described in terms of the antisymmetric second-rank tensor field $T_{\mu\nu}$. The vector-meson–baryon interaction Lagrangian, $L_{Int} = \frac{1}{2}\, g_1 \bar{B}\sigma_{\mu\nu}T_{\mu\nu}B + ig_2\bar{B}\gamma_\nu\partial_\mu T_{\mu\nu}B = \frac{1}{2}\, J_{\mu\nu}T_{\mu\nu} + J_\nu\partial_\mu T_{\mu\nu}$, gives the following interaction Hamiltonian, in the interaction representation: $H_{Int} = -L_{Int} + \frac{1}{4}\,[(1/m_T{}^2)\, J_{\mu\nu}J_{\mu\nu} + 2J_\mu J_\mu] + \frac{1}{2}[(1/m_T{}^2)\, J_{\mu\rho}J_{\mu\sigma} + J_\rho J_\sigma]\, n_\rho n_\sigma$. The normal dependent terms which appear in the S matrix vanish to any order in perturbation theory, and the S-matrix elements can be calculated by using the effective interaction Hamiltonian $(H_{Int})_{eff} = -L_{Int} + \frac{1}{4}[(1/m_T{}^2)\, J_{\mu\nu}J_{\mu\nu} + 2J_\mu J_\mu]$. (auth)

46732 REMARKS ON THE BLACK-BODY RADIATION AT VERY HIGH TEMPERATURE. Bouchiat, C. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., Lett., 2: 243-8(Aug. 21, 1969).

The properties of black-body radiation at very high temperatures are considered. It is shown that the pion-nucleon interaction, in the low-nucleon-density treatment, does not appear to be able to induce any local condensation of matter and antimatter in the black-body radiation, but such a possibility cannot be abso-

lutely excluded. It is also shown, using the delta resonance as a molecular state in equilibrium with pions and nucleons, that in statistical mechanics a resonance in a two-particle system can always be treated as a molecular state in thermal equilibrium with the resonating particles if the molecular width is small compared with kT. (J.F.P.)

46733 RESTRICTIONS ON THE VAN HOVE OVERLAPPING FUNCTION AT HIGH FREQUENCIES. Azimov, S. A.; Arushanov, G. G. (Tashkent State Univ.). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 22-6(1969). (In Russian).

A high-energy asymptotic behavior of derivatives of E(t) and G(t) functions at t = 0 point was found for elastic and inelastic scattering respectively under unitarity conditions. The obtained results were expressed by experimentally measured magnitudes of total cross sections. (tr-auth)

46734 ASYMPTOTIC BEHAVIOUR OF TOTAL CROSS SECTIONS AND RELATIONS BETWEEN REDUCED REGGE RESIDUES. Kobayashi, Reido (Science Univ. of Tokyo, Chiba, Japan). Progr. Theor. Phys. (Kyoto), 42: 138-9(July 1969).

It was previously pointed out that meson–baryon and baryon–baryon total cross sections in the 6 to 20 GeV energy range exhibit linear dependence on $s^{-\frac{1}{2}}$, where s is the square of the total energy in the barycentric system. It is reported that this property is derived from simple assumption on the Regge trajectories. The total cross section data are analyzed in this scheme. (L.B.S.)

46735 BACKWARD PEAKS AND REGGE PHENOMENOLOGY. Barger, V. (Univ. of Wisconsin, Madison). pp 181-219 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

Comparisons of recent Reggeized baryon exchange calculations with available experimental data on backward scattering are summarized. Consequences of the duality concept for baryon trajectories and residues are explored. Particular emphasis is placed on experiments that are needed to answer theoretical questions. (L.B.S.)

46736 SATURATION IN TRIPLET MODELS OF HADRONS. Greenberg, O. W. (Rockefeller Univ., New York); Zwanziger, D. Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 61-70(1968).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

Triplet models of hadrons are studied according to the criterion of saturation, namely, that the lowest-lying baryons contain exactly three triplets. Two main types of saturation are discussed: Pauli saturation, which depends on antisymmetrization of wave functions, and Coulomb saturation, which relies on the scheme of forces among the particles. The quark, quark-plus-singlet-core, two-triplet, and paraquark models are surveyed, and, using the saturation mechanisms, all of the models are made to satisfy the saturation criterion with the sole notable exception of the quark models which fails. (auth)

46737 EXACT STATIC-MODEL BOOTSTRAP SOLUTIONS FOR ARBITRARY 2 X 2 CROSSING MATRICES. Cushing, James T. (Univ. of Notre Dame, Ind.). J. Math. Phys. (N.Y.), 10: 1319-26(Aug. 1969).

Explicit, exact solutions, satisfying a bootstrap criterion in the form of Levinson's theorem and having real coupling constants, are exhibited for the two-channel Low equation for arbitrary real values of the parameter appearing in the 2 × 2 crossing matrix. This disproves a claim made recently that the bootstrap criterion will restrict values of the crossing-matrix parameter to those corresponding to the internal-symmetry group SU_2. It is demonstrated that the previous alleged proof is inconclusive. (auth)

46738 PREDICTION OF THE ONE-PION EXCHANGE CONTRIBUTION TO THE PROCESS $\pi^-p \to \pi^-p\omega$ WITH THE HELP OF THE VENEZIANO MODEL. Bender, I.; Rothe, Heinz J. (Univ., Heidelberg). Z. Phys., 227: 18-24(1969).

The one pion exchange contribution to the differential $\pi^-p \to \pi^-p\,\omega$ cross section is calculated assuming that the $\pi\pi \to \pi\omega$ amplitude associated with one of the vertices is described by the Veneziano formula, and that only a trivial dependence of the latter on the mass of the exchanged pion needs to be taken into account. The remaining unknown overall constant is then fixed by considering the decay $\omega \to 3\pi$. A rough comparison with preliminary data from a 16 GeV/c π^-p experiment shows that the one pion exchange model could possibly describe the reaction $\pi^-p \to \pi^-p\omega$ for $\pi\omega$ masses above 1.4 GeV. (auth)

46739 SPIN EFFECTS ON MASS SPECTRUM OF UNSTABLE PARTICLES. Resnick, L. (Carlton Univ., Ottawa). Nuovo Cim., 63A: 75-84(Sept. 1, 1969).

In the phenomenological analysis of the mass spectrum of an unstable particle created in an inelastic collision, it is well known that account must be taken of the energy dependences of the width, and the stable-particle cross-section. It is argued that an additional effect can contribute when the unstable particle has nonzero spin. It is shown that in the case of bosons, such effects are of second order and therefore probably negligible; whereas for fermions, the effect is in principle of first order and may not be negligible. The phenomenological parametrization should therefore allow for this. (auth)

46740 TESTS OF EXCHANGE DEGENERACY BY PROCESSES RELATED BY CROSSING. Gilman, F. J. (Stanford Univ., Calif.). Phys. Lett., 29B: 673-5(Aug. 18, 1969).

High energy scattering processes which are related by $s \longleftrightarrow u$ crossing are shown to have the same differential cross section at a given energy if they are governed by the exchange of Regge trajectories which are exchange degenerate. Various experimental tests of this are discussed. (auth)

Strong (Baryon No. ≥ 2)

Refer also to abstract 46734.

46741 HIGH ENERGY SCATTERING OF COMPOSITE PARTICLES. Formanek, J. (Univ., Geneva). Nucl. Phys., B12: 441-59(1969).

The general scattering amplitude formula for the case when target as well as beam particles are composite is found. A graphical method is proposed which simplifies the problem substantially. Some special examples are discussed in more detail. (auth)

46742 VARIATIONAL CALCULATION OF NEUTRON–PROTON SCATTERING. Hasegawa, Kenji (Fukui Univ., Japan). Progr. Theor. Phys. (Kyoto), 42: 36-49(July 1969).

The Kohn variational principle for the scattering amplitude is derived in a heuristic way different from the usual procedure. This principle is applied to the calculation of the S-phase shifts and the differential cross sections for neutron-proton scattering up to about 200 MeV. A central force involving the hard core is taken. The shape of the potential is assumed to be exponential. The results of the variational calculation are compared with those of the exact calculation and with experiments. The agreement among them is comparatively good in view of the simplicity of the trial functions and the potential. (auth)

46743 CONTRIBUTIONS OF SPIN, ANOMALOUS MAGNETIC MOMENT, AND FORM FACTORS TO THE STOPPING POWER OF MATTER FOR PROTONS AND MUONS AT EXTREME RELATIVISTIC ENERGIES. Turner, J. E. (Oak Ridge National Lab., Tenn.); Neelavathi, V. N.; Vora, R. B.; Subramanian, T. S.; Prasad, M. A. Phys. Rev., 183: 453-7(July 10, 1969).

The stopping power of matter for protons and muons is calculated without the usual restriction that $\gamma m \ll M$, where M is the rest mass of the proton or muon, m is that of the electron, $\gamma = (1-\beta^2)^{-\frac{1}{2}}$, and β is the ratio of the speed of the proton or muon to the speed of light. The calculation includes the effects of the incident proton's spin, anomalous magnetic moment, and form factors, the muon being considered as a point particle that obeys the Dirac equation. The contributions of these effects to the stopping powers of aluminum, copper, and lead are evaluated numerically for protons and muons up to $\gamma = 10^4$ (~10^4-GeV protons and ~10^3-GeV muons), where they amount to about 10%. Restricted energy-loss values with cutoff energies of 1.1 and 8.0 MeV are calculated for protons and muons in water. (auth)

46744 EXTENSION OF JASTROW'S METHOD FOR THE QUANTUM MECHANICAL MANY-BODY PROBLEM WITH STRONG FORCES. I. Ali, S.; Grypeos, M. E.; Kok, L. P. (International Atomic Energy Agency, Trieste, Italy). Progr. Theor. Phys. (Kyoto), 41: 1217-26(May 1969).

An extension of Jastrow's method for the treatment of the quantum-mechanical many-body problem with strong forces is proposed. A system of N identical particles (nucleons) to which two additional particles S have been attached is considered and a detailed study is performed (in the case $\lim_{\Omega\to\infty}^{N\to\infty} N/\Omega = \rho$, Ω being the volume in which the system is included) by using cluster expansion techniques. A trial expression for $E_{S_1S_2}$, the energy required to separate the two extra particles from the system and

from each other, is derived and some possibilities are discussed. (auth)

46745 EFFECTIVE NUCLEON NUMBER IN HIGH-ENERGY REACTIONS. Jackson, D. F. (Univ. of Surrey, Guildford, Eng.). Nuovo Cim., 63A: 343-53(Sept. 1, 1969).

Certain high-energy reactions have recently been analyzed using impulse approximation and closure. This leads to an expression for the cross section in which the leading term has the form of the product of the appropriate free two-body cross section and a number N(A) which may be regarded as the effective number of nucleons participating in the reaction. Calculations are carried out in order to study the sensitivity of N(A) to uncertainties in the parameters of the two-body scattering amplitude and in the parameters of the nuclear-density distribution. A discussion is given of the validity of the basic assumptions on which this formalism is based. (auth)

46746 DISPERSION CALCULATIONS FOR p–d SCATTERING $E_p \lesssim 160$ MeV, AND THE EXISTENCE OF BROAD RESONANCES IN THE THREE-NUCLEON SYSTEM. Ebenhoeh, W.; Rinat-Reiner, A. S.; Avishai, Y. (Weizmann Inst. of Science, Rehovoth, Israel). Phys. Lett., 29B: 638-41(Aug. 18, 1969).

N/D equations for elastic p-d scattering were solved. Differential cross sections agree with experiment for $0 < E_p < 150$ MeV except around minima in the region 40 MeV $\lesssim E_p \lesssim$ 80 MeV. Theoretical Argand plots are indicative of a broad ^{42}P resonance at (14–5i) MeV and a ^{22}P resonance at (18–8i) MeV. It is further found that close to threshold there exist virtual ^{22}S and ^{24}S states and possibly, a virtual ^{42}S state. (auth)

Particle Invariance Principles and Symmetries

General

Refer also to abstract 46812.

46747 THE REPRESENTATIONS OF THE EUCLIDEAN GROUP E_2 IN THE DESCRIPTION OF UNEQUAL MASS SCATTERING AMPLITUDES. Hadjioannou, F. T. (Univ. of Athens. Democritus Nuclear Research Center, Athens). Nucl. Phys., B12: 353-72(1969).

The t = 0 unequal mass scattering amplitude is expressed in terms of irreducible representations of the group E_2, the light-like little group of the inhomogeneous Lorentz group. The representation exhibits neatly the analytic properties of the scattering amplitude without the difficulties of the usual Regge pole analysis around $\cos\theta_t = 1$, at t = 0 unequal mass scattering. Various characteristic features of the representation, as the exponential or oscillatory asymptotic behavior in s are discussed for their theoretical and experimental implications. (auth)

46748 HARMONIC ANALYSIS IN AN $SU_{1,1}$ BASIS. MacFadyen, N. W. (Cambridge Univ., Eng.). Nuovo Cim., 62A: 925-48 (Aug. 21, 1969).

The theory of harmonic analysis on $SL_{2,C}$ is developed using an $SU_{1,1}$ basis. It is found that regarded as an integral kernel, the Fourier transform (FT) of a function defined over the group acquires two additional labels τ representing the two disjoint subspaces needed in the analysis. The representation functions are used to discuss $SU_{1,1}$-bicovariant distributions: it is found that the FT cannot be carried out using them alone, because of parametrization difficulties. The problem of equivalence is discussed; conditions upon the transforms obtained; and functions "of the second kind" shown to be just the representation functions themselves. The work is applied to analysis of the two-particle elastic-scattering amplitude at and away from $t_\mu = 0$, and nonunitary representations used to give a natural description of daughter trajectories and their properties. (auth)

46749 L'EXTENSION DU GROUPE DE POINCARE AUX SYMETRIES INTERNES DES PARTICULES ELEMENTAIRES, GIF-SUR-YVETTE, [FRANCE], 1er–5 AVRIL 1966. (Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, [France], 1–5 April 1966). Colloques Internationaux du Centre National de la Recherche Scientifique, No. 159. Paris, Centre National de la Recherche Scientifique, 1968. 149p. (In French and English). (CONF-660467).

The conference included 13 papers. Separate abstracts were prepared for each paper. (J.F.P.)

For abstracts of individual papers see: 46638, 46696, 46736, and 46750–46759.

46750 CENTRAL DISTRIBUTIONS AND CHARACTERISTICS OF THE POINCARE GROUP. Fuchs, G.; Renouard, P. (Ecole Polytechnique, Paris). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 17-24(1968). (In French).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

An analogous method to those previously used for the central distributions and characteristics of the Poincaré group is presented. In this method the idea of a function on Cartan subgroup, invariant by a Weyl group, is replaced by the idea of a central distribution. (J.F.P.)

46751 DEFORMATIONS OF THE POINCARE GROUP. Levy-Nahas, M. (Ecole Polytechnique, Paris). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 25-45(1968). (In French).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

The discussion of Poincaré group deformations includes a review of some definitions of the cohomology of Lie algebras, Lie algebra deformation, contraction, applications to the Poincaré group, and Lie algebra deformations. (J.F.P.)

46752 UNIFICATION OF INTERNAL AND EXTERNAL SYMMETRIES. Flato, M.; Sternheimer, D. (Faculte des Sciences, Lyon). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 47-60(1968). (In French).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

The unification of internal and external symmetries is treated from the point of view of mathematics. Structural problems are considered in the unification of Lie algebras. The mass spectra are then discussed. (J.F.P.)

46753 RELATIVISTIC GENERALIZATIONS OF DYNAMIC GROUPS. Bacry, H. (Univ., Marseille). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 71-6(1968). (In French).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

The cases of two particles interacting by a spherical potential and the energy levels of the hydrogen atom are considered. The results discussed were given previously. (J.F.P.)

46754 PROPERTIES OF REPRESENTATIONS OF HIGHER SYMMETRY GROUPS. Raczka, R. (Inst. of Nuclear Research, Warsaw. International Centre of Theoretical Physics, Trieste, Italy). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 77-84(1968).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

The properties of degenerate representations of arbitrary-rank U(p,q) groups are considered. The explicit construction of the maximal set of commuting operators (m.s.c.o.) in the representation space, the spectral properties of m.s.c.o., explicit construction of eigenfunctions of the m.s.c.o., and the decomposition of the representation of the noncompact symmetry group with respect to the maximal compact subgroup are discussed. Also a new class of infinite-dimensional irreducible representations of the Lie algebras of compact unitary groups U(p) is presented. (J.F.P.)

46755 POSSIBILITY OF THE UNIFICATION OF THE INTERNAL AND EXTERNAL BEHAVIOR OF ELEMENTARY PARTICLES BY MEANS OF ISOMETRIC MOTION GROUPS OF RIEMANNIAN VARIETIES. Vigier, J. P. (Institut Henri Poincare, Paris). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 85-92(1968). (In French).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

Several examples of the general theory of isometric motion groups on Riemannian varieties are briefly considered. These examples are the modification of the region of interaction by particle strong interactions, a principle quantum number for the degeneracy of bosons, the geometrization of the short-range strong and weak interaction forces and representation of the particles by small varieties strongly curved in the interior of a pentadimensional space–time, and lastly the geometrical representation of the unification process. (J.F.P.)

46756 ON THE SERIES OF UNITARY IRREDUCTIBLE REPRESENTATIONS OF SU(2,2). Kihlberg, A. (Univ., Goteborg). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 93-8(1968).

From International Symposium on the Extension of the Poincare

Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

The determination of a number of series of unitary irreducible representations of SU(2,2) is presented. The approach used is related and complimentary to a previously used method. Only one quotient space as a carrier space for the Hilbert space is used irrespective of the type of series sought. Also the metric is adjusted according to the type of series it is desired to derive. The basis of the calculations is the Iwasawa decomposition G = K A N of any connected semisimple Lie group into the product of three subgroups. (J.F.P.)

46757 THE LOCAL WIGNER–ECKART THEOREM AS A THEOREM WITH CLASS. Hillion, P. (Institut Henri Poincare, Paris). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 99-105(1968). (In French).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

The use of noncompact Lie groups in elementary particle theory has lead to results in good agreement with those of experiment. It is shown that these coincidences are not accidental, but are a consequence of the fact that the Wigner–Eckart theorem, in its local form, is a theorem of group form. The group SU(p,q) is discussed. (J.F.P.)

46758 CONSERVED CURRENTS AND BROKEN SYMMETRIES. Robinson, D. W. (Institut des Hautes Etudes Scientifiques, Bures-sur-Yvette, France). Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 131-5(1968).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

A Goldstone-type theorem concerning the connection between locally conserved currents and global symmetreis in relativistic field theory is discussed. It is shown under very general circumstances that such a behavior is not possible if the smallest mass in the theory is nonzero. The work is carried out in the framework of algebraic field theory. (J.F.P.)

46759 LIMITATIONS ON THE SPONTANEOUS BREAKDOWN OF SYMMETRIES. Sen, R. N. (Univ., Naples. Istituto Nazionale di Fisica Nucleare, Naples. GNSM, Naples); Umezawa, H. Colloq. Int. Cent. Nat. Rech. Sci, No. 159, 137-46(1968).

From International Symposium on the Extension of the Poincare Group to Internal Symmetries of Elementary Particles, Gif-sur-Yvette, France. See CONF-660467.

A result is established in the theory of spontaneous breakdown of symmetry. This is a quantized Lagrangian or equivalent field theory in which the continuous internal symmetries of the Lagrangian which give rise to locally conserved currents are broken in observations. (Observation implies the relation phenomena of physical particles.) It is pointed out that a spontaneous breakdown implies that the shape of the invariance transformation written in terms of the physical fields differs from that written in terms of the basic fields. The results for the original invariance are described as the dynamical rearrangement of symmetries. The limitation of the forms of the dynamical rearrangement by the original symmetry is discussed. (J.F.P.)

46760 CLEBSCH–GORDAN COEFFICIENTS AND FUNCTIONS OVER COSETS. Klink, William H. (Univ. of Iowa, Iowa City). J. Math. Phys. (N.Y.), 10: 1477-90(Aug. 1969).

Functions over cosets are used to obtain Clebsch–Gordan coefficients of induced unitary representations of noncompact groups. In particular, the Clebsch–Gordan coefficients of the Poincaré group are obtained using functions over cosets. It is also shown how the Clebsch–Gordan coefficients of other groups having induced irreducible representations, such as the Lorentz group, may be obtained. (auth)

46761 ON THE LADDER REPRESENTATIONS OF THE O (4,2) GROUP. Leal Ferreira, P. (Instituto de Fisica Teorica, Sao Paulo, Brazil). Rev. Mex. Fis., 18: 233-45(1969).

A study of the ladder representations of the O(4,2) group is done, using algebraic methods, for the chain O(4,2) ⊃ O(4,1) ⊃ O(4), and the matrix elements of the infinitesimal generations between ladder-states are explicitly calculated. (auth)

46762 FOLDY–WOUTHUYSEN TRANSFORMATIONS, LORENTZ TRANSFORMATIONS, AND THE DE SITTER GROUP. De Vries, E. (Univ., Groningen, Netherlands). Physica, 43: 45-9(July 1, 1969).

It is shown that generalized Foldy–Wouthuysen transformations have to do with a four-dimensional rotation group which is a subgroup of the de Sitter group. Foldy–Wouthuysen transformations are not related to Lorentz transformations. (auth)

Applications (Electromagnetic and Weak)

Refer also to abstracts 46666 and 46782.

46763 BREAKING OF CHIRAL SYMMETRY FOR PSEUDOSCALAR MESONS. Auvil, P. R.; Deshpande, N. G. (Northwestern Univ., Evanston, Ill.). Phys. Rev., 183: 1463-8(July 25, 1969).

The content of the generator-divergence commutators proposed by Gell-Mann, Oakes, and Renner is analyzed using the pole-dominance and smoothness approximations for the two- and three-point functions in the theory. This leads to very general sum rules which include both Hamiltonian and vacuum symmetry breaking. There are many different solutions to these sum rules. In particular, two interesting limiting cases, one with the Hamiltonian approximately SU(2) × SU(2)-invariant and the other with the vacuum approximately SU(2) × SU(2)-invariant, are found to be allowed. When $\eta-\eta'$ mixing is included and the smoothness conditions imposed, a consistent solution exists which is in good agreement with present experimental results. The applications of this model to the K_{l3} form factors are considered, and results are compared with experiment as well as other theoretical work. (auth)

46764 SU_3 MASS FORMULA FOR BOSONS AND $X^0-\eta$ MIXING. Willey, R. S. (Univ. of Pittsburgh). Contract AT(30-1)-3829. Phys. Rev., 183: 1397-1402(July 25, 1969).

The possibility of a linear SU_3 mass formula for bosons and consequent non-negligible $X^0-\eta$ mixing is considered. The existence of $X^0-\eta$ mixing is indicated by the experimental ratio of the $\pi^0 \to 2\gamma$ and $\eta \to 2\gamma$ rates. A phenomenological SU_3 analysis, with a minimum of dynamical assumptions, of the electromagnetic decay modes $P \to 2\gamma$, $V \to P+\gamma$, and $P \to V+\gamma$ is made with the purpose of distinguishing between the linear and quadratic mass formulas. (auth)

46765 PARITY-NONCONSERVATION INTERNUCLEON POTENTIALS AND THEIR EFFECT IN ELECTROMAGNETIC TRANSITIONS. Grama, N. Stud. Cercet. Fiz., 21: 167-78 (1969). (In Rumanian).

The discussion of parity nonconserving internucleon potentials and their effects in electromagnetic transitions covers the asymmetry effect in gamma transitions, angular distribution of unpolarized radiation from an oriented nuclear system, emission of circularly polarized gamma radiation, perturbed gamma–gamma correlations, and the expected magnitude of the effect. (J.F.P.)

46766 COMMENTS ON $K_1^0 \to K_2^0$ REGENERATION. Kobzarev, I. Yu. (Inst. of Theoretical and Experimental Physics, Moscow). Yadern. Fiz., 9: 1110-11(May 1969). (In Russian).

It is known that the amplitude of the regeneration $K_2^0 \to K_1^0$ in matter at an angle θ is proportional to $f(\theta) - \bar{f}(\theta)$, where $f(\theta)$ and $\bar{f}(\theta)$ are respectively the scattering amplitudes K and $\bar{K}$. It is shown that this statement is correct also with nonconservation of charge and parity for the regeneration $K_L \to K_S$, in spite of the change in wave functions of K_L and K_S. The scattering amplitudes K and $\bar{K}$ are multiplied by complex numbers p and q. The states K_L and K_S are nonorthogonal, and need not be normalized. After scattering a state with a wave function proportionate to the difference in scattering amplitudes is formed. Coefficients are determined by comparison. (TTT)

46767 CURRENT DEFINITIONS AND SCHWINGER TERMS. Cohen, S. L. (Univ. of Oregon, Eugene). Nuovo Cim., 62A: 881-8(Aug. 21, 1969).

It is demonstrated that the apparent breakdown of Lorentz invariance in current-current interaction theories may be resolved, at least to lowest order in the coupling, by altering the definition of the current j_μ. This is accomplished by multiplying the naive definition by an exponential factor, $[i\lambda\int_{x-\epsilon}^{x+\epsilon} d\varphi^\nu j_\nu(\varphi)]$, and proving the theory to be consistent with Lorentz invariance to lowest order in a Taylor-series expansion of the exponential. Possible effects due to higher-order terms in the exponential are briefly mentioned, including the possibility of their affecting the validity of the CVC and PCAC theorems. (auth)

46768 NEUTRAL CURRENTS AND CP NONCONSERVATION IN WEAK INTERACTIONS. Oakes, R. J. (Northwestern Univ., Evanston, Ill.). pp 270-81 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

The relation of the approximate SU(3) × SU(3) symmetry of the strong interactions to the other fundamental interactions is ex-

plored. The possibility is emphasized that in addition to the recognized weak and electromagnetic interactions, which are constructed from certain currents belonging to the vector and axial vector octets, there may exist another interaction, constructed in a similar manner from the remaining neutral currents in these same octets, which violates CP invariance in a natural way. A brief survey is given of the present data relevant to neutral currents. Some specific models are discussed. (L.B.S.)

Applications (Strong)

Refer also to abstracts 46604, 46711, and 47063.

46769 (ITF-69-42) SOME CONSEQUENCES OF THE CHIRAL U(3) x U(3) DYNAMICS FOR VECTOR AND AXIAL VECTOR RESONANCES. Sabo, V. I.; Torich, Z. Z. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 9p. (In Russian). (CONF-690417-15). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

The vector and axial vector mesons are introduced into the chiral U(3) × U(3) dynamics in a gauge invariant way. Decay widths of these mesons are calculated both without symmetry breaking and with symmetry breaking. Obtained results are in satisfactory agreement with experiment. (auth)

46770 (ITF-69-45) THE NONLINEAR CHIRAL U(3) x U(3) DYNAMICS OF LOW-ENERGY BB AND PB INTERACTIONS. Lomsadze, Y. M.; Sabo, V. I.; Torich, Z. Z.; Spiegel, A. G. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 16p. (CONF-690417-13). Dep. CFSTI (U. S. Sales Only).

From 3rd Conference on Axiomatical Field Theory and Theory of Elementary Particles, Kiev, USSR.

On the basis of the broken nonlinear chiral U(3) × U(3) dynamics the physical consequences are calculated for PB and BB interactions at low energies (up to ~50 MeV in the L frame). The contributions from P, V_μ, and A_μ nonets are taken into account. The results obtained are in satisfactory agreement with experiment. (auth)

46771 (JINR-P2-4522) SUM RULES FOR ρ^0, ω, ϕ MESON LEPTONIC DECAYS IN BROKEN SU(3) SYMMETRY. Gerasimov, S. B. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 14p. (In Russian). Dep. CFSTI (U.S. Sales Only).

The relations between the ρ^0, ω, ϕ-meson leptonic decay widths are discussed under various assumptions on the SU(3) breaking and $\omega-\phi$ mixing. The results are compared with the e^+e^--colliding beam data. (auth)

46772 (NP-18008) SU(3) x SU(3) BREAKING AND THE MESON SYSTEM. Note No. 223. Mohanti, A. K. (Rome Univ. (Italy). Istituto di Fisica). June 10, 1969. 17p. Dep. CFSTI (U. S. Sales Only).

A chiral Lagrangian model of spin-0 and spin-1 mesons is used transforming linearly under SU(3) ⊗ SU(3) broken in a way to preserve field-current identity, SU(3) invariance of Schwinger terms, and PCAC at SU(2) level, and $F_k/F_\pi f^+(0)$ is determined with reasonable agreement with experiment. (auth)

46773 CURRENT ALGEBRA WITH A MASS CONDITION. Noga, M.; Vallinkoski, M. (Univ. of Helsinki). Nucl. Phys., B12: 460-70(1969).

The realization of the algebra of hadronic currents, recently proposed by Weinberg, in which a condition on the mass operator is adjoined to a current algebra is studied in a simple model of particles with an SU(2) (isospin) internal symmetry. The only consistent solution is found to be one in which the particles are classified according to an irreducible representation of SL(2,C) group. The mass spectrum is linear in isospin. (auth)

46774 BROKEN SU(3) ALGEBRA OF FIELDS SPECTRAL-FUNCTION SUM RULES AND $\omega-\phi$ MIXING. Burnel, A. (Univ., Liege). Nucl. Phys., B12: 373-82(1969).

An SU(3) algebra of fields with unequal bare masses and coupling constants is constructed. It is shown that, if currents satisfy current algebra commutation relations, the first Weinberg sum rule is implied while the second one is obtained in a modified form which is, in general, useless. The ω-ϕ mixing problem is investigated by introducing an additional relation. Depending on the form of this relation, each of the various models previously used is reobtained. A new model is also investigated and comparison with experiment is shown to favor it. (auth)

46775 SECOND-SPECTRAL-FUNCTION SUM RULES IN THE U(12) ALGEBRA OF CURRENTS. Perrin, Robert (Brandeis Univ., Waltham, Mass.). Phys. Rev., 183: 1371-3(July 25, 1969).

Second-spectral-function sum rules following from quark-model commutation relations, and the assumption that the representation 27 does not contribute to certain matrix elements, are derived. The relation between the sum rules and asymptotic SU(2) ⊗ SU(2) symmetry is discussed. (auth)

46776 CHIRAL SU(3) ⊗ SU(3) AS A SYMMETRY OF THE STRONG INTERACTIONS. Dashen, Roger (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 183: 1245-60(July 25, 1969).

Starting with the modern developments of current algebra and the hypothesis of partially conserved axial-vector current, it has gradually become apparent that the strong interactions are almost invariant under the group SU(3) ⊗ SU(3). In the limit that symmetry breaking is neglected, SU(3) ⊗ SU(3) does not appear as a symmetry of the particle states as SU(3) does, but rather as a symmetry realized by eight Goldstone bosons, i.e., the pseudoscalar octet. Most papers on SU(3) ⊗ SU(3) symmetry have been concerned with soft-meson theorems and their connection with effective Lagrangians. This paper is devoted to other aspects of the symmetry. Part of the paper is frankly pedagogical. The physics behind a symmetry realized by way of Goldstone bosons is brought out through a study of the σ model. Then the general principles are stated abstractly and applied to the hadrons. One of the new results presented here is that there are two distinct ways in which SU(3) ⊗ SU(3) can be realized. In both cases there is an octet of massless pseudoscalar mesons. The two possibilities differ in the residual symmetry of the hadron spectrum: In one case, it is only SU(3); in the other, it is SU(3) times a discrete symmetry, which leads to parity doublets. It is conjectured that some of the observed parity doubling in nucleon resonances is a consequence of this new discrete symmetry. Symmetry breaking is discussed in detail and is found to be very complex. In particular, it is shown that, at least for the pseudoscalar-meson masses, octet enhancement can never occur for first-order perturbations around an SU(3) ⊗ SU(3)-symmetrical limit. Since octet enhancement is an empirical fact, one is forced to conclude that lowest-order perturbation theory is not a good approximation. In connection with octet enhancement, it is shown how one can use a principle of pole dominance in the angular momentum plane to replace scalar "tadpole" mesons with Regge trajectories. (auth)

46777 SOFT PIONS, CHIRAL SYMMETRY, AND PHENOMENOLOGICAL LAGRANGIANS. Dashen, Roger; Weinstein, Marvin (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 183: 1261-91(July 25, 1969).

A method is devised for extracting the entire content of the joint assumptions of partially conserved axial-vector current (PCAC) and current algebra. This technique is used to derive a set of identities which generate all possible soft-pion theorems; moreover, the direct relationship between the PCAC–current-algebra approach and the so-called phenomenological Lagrangian approach to deriving these theorems is explicitly established. The technique used throughout clearly reveals all of the assumptions inherent in the phenomenological Lagrangian approach, and provides formal expressions for the correction terms to the soft-pion theorems following from the Lagrangian formalism. Particular attention is paid to clarifying the relationship between so-called "PCAC correction terms" and "Σ terms," with special emphasis placed upon their role in the calculation of formulas for pion–pion scattering. It is argued that the results strongly suggest that the only appealing explanation for the success of the PCAC hypothesis is that the real world satisfies an approximate SU(2) ⊗ SU(2) symmetry; and, moreover, in a world in which such a symmetry is exact, the pion corresponds to a Goldstone boson. (auth)

46778 BOSON FOCK-SPACE REPRESENTATIONS OF CHARGE-DENSITY ALGEBRAS. I. EUCLIDEAN-INVARIANT REPRESENTATIONS. Divakaran, P. P. (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 183: 1189-99(July 25, 1969).

A systematic method of constructing and studying a class of representations of charge-density algebras is presented. These representations are constructed in terms of auxiliary creation and annihilation operators on the Fock space of spinless bosons; the method is a generalization of the procedure used by Schwinger in the case of SU_2. They are not, in general, factorizable and can accommodate continuous as well as discrete mass spectra. The emphasis is on general properties and techniques of boson Fock-space representations. After an account of the essentials of the

Schwinger method as applicable to an arbitrary finite-dimensional Lie algebra, a description of its generalization to the algebra of SU_3 charge densities is given. It is shown that, within the class of representations considered here, operators which formally represent charges and charge densities exist only in the Fock representation of the creation and annihilation operators, so that the problem of inequivalent representations is not present here, in contrast to canonical field theories. The one-particle subspace of the Fock space is considered in detail, and its reduction to irreducible subspaces is carried out, purely algebraically, by constructing all Casimir operators and diagonalizing them. As an illustrative example of how to incorporate the space-time transformation properties, rotations and spatial translations are then considered. Irreducible bases having the right Euclidean transformation properties are found by extending the algebra to include generators of rotations and translations. At least in this case of Euclidean-invariant representations, there is no need to resort to infinite-momentum methods. (auth)

46779 BROKEN SU(3) AND STRONG DECAYS. Rao, Pejavar Sridhar. Syracuse, N. Y., Syracuse Univ., 1968. 150p.

Thesis.

The decay rates of resonances have long been used in particle physics as a means of establishing and checking SU(3) symmetry. In using them, it is usually assumed that, apart from phase space, the matrix element for the decay is SU(3)-invariant up to 20%. A model for checking this assumption is proposed. The model makes the following hypotheses: (i) The coupling constants and the dispersion relation subtraction constants are SU(3)-invariant. (ii) The masses used in the evaluation of the matrix elements are the physical masses, and are not SU(3)-invariant. (iii) One may use perturbation techniques. This amounts to saying that perturbation theory is good for checking percentage deviations, or alternatively, that it is a self-consistency check. On the basis of the third hypothesis, the decay matrix elements are identified with the amplitudes for a triangle graph, and are evaluated explicitly for the strong decays of the $\frac{3}{2}^+$ decuplet into the $\frac{1}{2}^+$ and 0^- octets, of which there are four, namely $N^* \to N\pi$, $Y^* \to \Lambda\pi$, $Y^* \to \Sigma\pi$, and $\Xi^* \to \Xi\pi$. The intermediate lines of the triangle graph are also assumed to belong to the same three multiplets. It follows then that there are four different modes for the decay, and calculations are carried out for each mode separately. The calculations are based on effective Lagrangians and Feynman rules. One is then led to the conclusions that the mass-breaking among the SU(3) multiplets are responsible for the symmetry-breaking among the decay amplitudes, and that the magnitude of the variations among the matrix elements are of the order of 20%, which is usually expected. These conclusions are further reinforced by a variation of the model. The masses of the intermediate particles are artificially increased so as to simulate the effect of SU(3) multiplets of large mass, where presumably the mass-breaking is smaller than that among the presently-known multiplets. Several such variations are attempted. (Disser. Abstr.)

46780 SPONTANEOUSLY BROKEN SU_3 AND MASSIVE VECTOR MESONS. Kim, Y. S.; Markley, F. Landis (Univ. of Maryland, College Park). Nuovo Cim., 63A: 60-74(Sept. 1, 1969).

A Lagrangian model of SU_3 symmetry that is applicable to breakdown on a singular layer of SU_3 octet space as well as on the general layer is investigated. In both cases, gauge particles corresponding to broken components of the symmetry acquire mass, while those corresponding to the little group of exact symmetries remain massless. The gauge-invariance properties of the model, including symmetry-breaking effects are discussed. (auth)

46781 COVARIANT O_4 PROPAGATORS AND TOLLER POLES. II. SYMMETRY BREAKING. Jones, H. F. (Imperial Coll. of Science and Tech., London). Nuovo Cim., 62A: 829-40 (Aug. 21, 1969).

The covariant M-function approach to Toller poles is extended in a natural way within the framework of the Van Hove model to deal with nonforward and unequal-mass scattering. The formalism reproduces the perturbation formula for daughter trajectories both for bosons and fermions and gives factorized Regge residues, which may easily be calculated to any order in t. Detailed discussions are given of M = 0 exchange (in spinless scattering), M = ½ exchange (in πN scattering) and M = 1 exchange (in NN scattering) It is hoped that the formalism will prove useful in dealing with higher symmetries. (auth)

46782 REPRESENTATION MIXING IN THE ALGEBRA OF VERTEX STRENGTHS. Horwitz, L. P. (Univ. of Denver); Kantorovich, A. Phys. Rev., 183: 1300-12(July 25, 1969).

An admixture of $[U(6) \times U(6)]_S$ representations under a common U(12) parentage provides the required amount of D coupling for high-energy scattering. Production of N*(1400), classified in this framework, is found to be consistent. $(D/F)_A$, G_A/G_V, and the ratio of magnetic moments are calculated for the nucleon; consistency with mass splitting is checked. In an appendix, an alternative scheme is discussed in which the admixture is derived from B = 1 states involving $q\bar{q}$ pairs. (auth)

46783 ON THE SO(4,1) MODEL FOR HADRONS. Inomata, Akira; Peak, David (State Univ. of New York, Albany). Progr. Theor. Phys. (Kyoto), 42: 134-6(July 1969).

An attempt is made to show, assuming the SO(4,1) de Sitter symmetry of space-time, that the curvature of the micro-realm for the hadron is much greater than that caused by gravitation. A geometric model is presented in which the hadron may be visualized as an extended particle. (L.B.S.)

46784 CHIRAL SYMMETRY AND THE PVV INTERACTION. Brown, Laurie M.; Munczek, Herman (Northwestern Univ., Evanston, Ill.). pp 257-69 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

The chiral SU(2) × SU(2) Lagrangian is considered on the O(4) formalism for describing the pion, the rho-meson and their chiral partners. It is shown that by allowing a possible modification of either PCAC or field-algebra, the Gell–Mann–Sharp–Wagner type of pseudoscalar-vector-vector interaction can be constructed for the $\omega\rho\pi$ interaction. (L.B.S.)

46785 HARMONIC-OSCILLATOR STATES AND THE α PARTICLE. II. CONFIGURATION-SPACE STATES OF ARBITRARY SYMMETRY. Aguilera-Navarro, V. C. (Univ. de Mexico, Mexico City); Moshinsky, M.; Kramer, P. Ann. Phys. (N. Y.), 54: 379-93(Sept. 1969).

The general projection technique for getting translationally invariant configuration-space four-particle states of arbitrary symmetry and total orbital angular momentum, out of harmonic-oscillator states in the single relative coordinates is determined. (auth)

46786 MESON MASS SPECTRUM. Englert, F.; Brout, R.; Truffin, C. (Univ. Libre, Brussels). Phys. Lett., 29B: 686-8(Aug. 18, 1969).

A previous discussion of chiral algebra is extended. The most important result is $m_\eta^2 = 1/4$, and $m_\eta^2 = 3/4$. The universal slope $[\alpha']^{-1} = 2m_\pi^2$ is used as the unit of mass. The meson spectrum, within a one-particle approximation, is obtained from the assumption of SU(3) × SU(3) algebra, SU(2) × SU(2) symmetry, and the absence of exotic resonances. (J.F.P.)

Field Theories

General

46787 CLASSICAL RELATIVISTIC MECHANICS OF PARTICLES WITH SPIN. Eby, Peter Byerly. Chapel Hill, N. C., Univ. of North Carolina, 1968. 89p.

Thesis.

It is possible to describe interactions of classical particles from the point of view of direct action as well as from the particle-field point of view and these two viewpoints can play complementary roles. One takes the former approach and attempts to construct an action-at-a-distance theory for particles with spin consistent with relativistic invariance and the conservation laws for linear and angular momentum. This theory contains as a special case the half retarded plus half advanced electrodynamics of charged particles with spin. Then the equations of motion are given for a particle in an external electromagnetic field which corresponds to this special case and these equations are compared to some of the standard theories of spinning particles in electromagnetic fields. The main points of difference are that one includes in the equations the possibility of variable mass and spin magnitude and the theory ensures the validity of Newton's First Law. (Diss. Abstr.)

Quantum Field Theory

Refer also to abstracts 46639, 46758, 46759, and 46855.

46788 (JINR-P2-4515) LAGRANGIAN FORMALISM FOR THE HALF-INTEGRAL SPIN FIELDS WITHOUT ADDITIONAL CONDITIONS. Zaikov, R. P. (Joint Inst. for Nuclear Research,

Dubna (USSR). Lab. of Theoretical Physics). 1969. 17p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The Lagrangian formalism is considered both for finite component fields of half-integral spin without exclusion of the lowest spins and for infinite component fields (which are transformed on nonunitary representations of SL(2,C) group) with an arbitrary mass spectrum. It is shown that the free field Lagrangian can be constructed, from which follows positively definite energy. In the case of finite component fields the formalism is canonical. The interaction with an arbitrary tensor field is considered. (auth)

46789 (JINR-P2-4564) FERMI-GUPTA AND SCHWINGER-BLEULER SUBSIDIARY CONDITIONS. Polubarinov, I. V. (Joint Inst. for Nuclear Research, Dubna (USSR). Lab. of Theoretical Physics). 1969. 38p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Subsidiary conditions in electrodynamics are analyzed in the interaction and Heisenberg pictures. The effect of the conditions on the elements of S-matrix is investigated, S-matrix being taken both between the infinite and finite times. The work of subsidiary conditions in the quantized Yang-Mills and Einstein theories is briefly considered. The peculiarity of the usual S-matrix due to nonabelian gauge group is discussed. It is stressed that transformed S-matrix, possessing invariance with respect to the additive gauge group, satisfies the physical condition of unitarity. (auth)

46790 (SU-1206-200) PHYSICAL INTERPRETATION OF COMPLEX ENERGY NEGATIVE METRIC THEORIES. Gleeson, A. M.; Sudarshan, E. C. G. (Syracuse Univ., N. Y. Dept. of Physics). July 1969. 44p. (NYO-3399-200). Dep. CFSTI.

It has long been held that the divergences of field theory could be removed if the theory was formulated on a hilbert space with an indefinite metric. The difficulty of this approach was that the theory then possessed channels with negative probability and therefore violated unitarity. It was previously observed that this difficulty could be eliminated if negative metric states had complex energy. A model is produced which shows several of the difficulties associated with the Lee-Wick proposal. The existence of complex energies leads to interpretation difficulties and, in higher sectors, does not completely solve the unitarity problem. The model is used to show how the Lee-Wick conjecture can be extended to overcome the difficulties that are produced. The physical meaning of "good" theories with an indefinite metric are described. (auth)

46791 EQUIVALENCE OF FIVE-DIMENSIONAL FIELD EQUATIONS AND BARGMANN-WIGNER-SALAM EQUATIONS. Bakri, M. M. (Cairo Univ., Giza, Egypt). Nucl. Phys., B12: 341-52(1969).

It is shown that Salam's generalization of the Bargmann-Wigner equations, for particles of definite mass m and definite spin, is equivalent to two types of field equations of the form $S_{AB}p_B\psi = p_A\psi$: (i) The de Sitter-symmetric theory, in which $p_A = (p_\mu, p_5 = m)$, and S_{AB} are the infinitesimal generators of SO(4.1); (ii) The conform-symmetric theory, in which $p_A = (p_\mu, p_5 = m)$, $p_6 = 0$) and S_{AB} are the infinitesimal generators of SO(4.2). The tensorial and spin-tensorial realizations of the latter equations are derived; these are just the equations used in the $\bar{U}(12)$ theory. (auth)

46792 DILATATION COVARIANCE AND EXACT SOLUTIONS IN LOCAL RELATIVISTIC FIELD THEORIES. Rosen, Gerald (Drexel Inst. of Tech., Philadelphia). Phys. Rev., 183: 1186-8 (July 25, 1969).

Consideration is given to the invariance of field equations under space-time dilatations with (induced) transformation of constant parameters therein. Analysis of such "dilatation covariance" facilitates the determination of rigorous closed-form singularity-free solutions to essentially nonlinear classical field equations. More over, for essentially nonlinear quantized (boson) field theories, dilatation-covariance considerations facilitate the determination of rigorous closed-form solutions to the Schrödinger stationary-state equation. (auth)

46793 SUPERPOSITION THEORY FOR PHOTON FIELDS. Webber, J. C. (Univ. of Calgary, Alberta). Phys. Rev., 183: 1108-10(July 25, 1969).

An extension of previous results in the dynamics of coherent states is presented. The multimode quantized electromagnetic field state vector generated by superimposed sources, from a class that generates coherent states while acting alone, is obtained as a function of time. Equations are also given that describe the quantum statistical superposition of photon fields. The modes of the radiation field are coupled. (auth)

46794 CALCULATION OF SCATTERING FOR A SPINOR BETHE-SALPETER EQUATION. McInnis, B. C. (Univ. of California, Berkeley). Phys. Rev., 183: 1474-85(July 25, 1969).

The Bethe-Salpeter equation for the interaction of a spin-$\frac{1}{2}$ particle with a scalar particle via the exchange of a scalar particle is considered. For energies below the inelastic threshold, a modified Schwinger variation principle is used to compute the phase shifts. Compared to the analogous calculation for spinless particles, considerable structure is in evidence. Both the $S_{\frac{1}{2}}$ and the $P_{\frac{1}{2}}$ phase shift, if positive just above the elastic threshold, change sign in the physical region, while if they are negative just above the elastic threshold, they remain so. (auth)

46795 LIMIT $\hbar \to 0$ IN QUANTUM FIELD THEORY. Prokhorov, L. V. (Imperial Coll. of Science and Tech., London). Phys. Rev., 183: 1515-17(July 25, 1969).

The $\hbar$ dependence of an arbitrary diagram in a theory with an arbitrary interaction is investigated by a straightforward counting of the degree in $\hbar$. It is shown that as a rule the contributions of loop diagrams do not vanish in the limit $\hbar \to 0$. Remarks are made on the relevance of the $\hbar \to 0$ limit in quantum field theory to the actual classical limit. (auth)

46796 NOTE ON CAUSAL TACHYON FIELDS. Glueck, M. (Univ., Hamburg). Phys. Rev., 183: 1514(July 25, 1969).

It is shown that a causal Lorentz-invariant tachyon propagator is not expressible as a contracted Wightman function. (auth)

46797 EXCHANGE DEGENERACY AND THE POMERANCHUKON. Graham, R. H.; Logan, R. K. (Univ. of Toronto). Phys. Rev., 183: 1438-9(July 25, 1969).

It is shown that if exchange degeneracy is valid, the Pomeranchukon is not a Regge trajectory. (auth)

46798 QUANTUM ELECTRODYNAMICS AT SMALL DISTANCES. Baker, M. (Univ. of Washington, Seattle); Johnson, K. Contracts AT(30-1)-2098; AT(45-1)-1388B; AT(30-1)-3829. Phys. Rev., 183: 1292-9(July 25, 1969).

In an earlier paper, it was shown that if the vacuum polarization in quantum electrodynamics is calculated neglecting corrections to internal photon lines, then the charge renormalization diverges as a single power of the logarithm of a cutoff in every order of perturbation theory. It was further shown that if the coefficient of the logarithm $f(\alpha_\theta)$ has a zero, and a further positivity condition of f is satisfied, then the complete renormalized-photon Green's function is finite. These results are related to the Gell-Mann-Low investigation of renormalized quantum electrodynamics at small distances. In particular, the vanishing of the Gell-Mann-Low function ψ is shown to follow from the vanishing of f. This demonstrates why it is sufficient, from the point of view of the renormalized theory, to study quantum electrodynamics without photon self-energy corrections in order to examine the predictions of the theory at small distances. (auth)

46799 RENORMALIZATION GROUPS EXTENDED TO MASSES; APPLICATION TO THE STRUCTURE OF THE RENORMALIZATION CONSTANTS Z_3 AND m_0. Astaud, M.; Jouvet, B. (College de France, Paris). Nuovo Cim., 63A: 5-48 (Sept. 1, 1969).

By a precise elucidation of the axions from which renormalization "groups" result the most general "groups" which include mass renormalization can be constructed. The particular case involving only photon field and electron mass renormalizations is discussed in detail. An exact integral equation which can be put in a form generalizing that given by Gell-Mann and Low, allows one to show that a dependence of the bare charge α_θ on the observed one α is, contrary to an often quoted paradox, consistent with the renormalization group. It is demonstrated that in the cases where the bare or the observed mass of the electron is null or infinite, which should correspond to determined values of α, the formal perturbation expansion in α_θ of the photon vacuum polarization tensor is no more divergent than a single power of a logarithm. It is finally determined wherein lies the failure of the argument leading to the paradox stated above and discuss its implication. (auth)

46800 COMPACTNESS PROOFS ASSOCIATED WITH PARTIAL-WAVE LIPPMAN-SCHWINGER AND BETHE-SALPETER EQUATIONS. Choudhury, M. H. (Univ. of Hull, Quebec). Nuovo Cim., 62A: 841-63(Aug. 21, 1969).

The partial-wave Lippman-Schwinger equation for potentials V(r) satisfying certain quite weak conditions and the partial-wave Bethe-Salpeter equation (without Wick transformation) for two equal-mass spin-zero particles are reduced to infinite systems of linear equations in a manner such that the linear transforma-

tions which these systems of equations define are compact in Hilbert space for all physical values of the energy. Specifically, it is shown that these linear transformations belong to some class of compact linear operators in Hilbert space which are wider than those of the Hilbert–Schmidt class. (auth)

46801 MESOTRONS OF EDDINGTON. Klotz, A. H. (Univ. of Sydney). Nuovo Cim., 63B: 309-17(Sept. 11, 1969).

Some aspects of Eddington's fundamental theory are reviewed. It is shown that an electrically neutral particle of rest mass close to that of π^0-meson can be predicted using a quadruple phase reference frame. An attempt is made to calculate the lifetimes of the π-mesons using an extension of Eddington's arguments. (auth)

46802 ON A FUNCTIONAL APPROACH TO THE LEE MODEL. Dittrich, W. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 63A: 85-107(Sept. 1, 1969).

Schwinger's functional differentiation methods are employed to approach the Lee model from a relativistic point of view. Topics discussed include: commutation relations and indefinite metric, sum rules, and spectral representations. It is argued that Heisenberg's results using a Hilbert space with indefinite metric are not in contradiction with the functional description based on the action principle. The technical advantages of the fundamental methods are indicated by an extended Lee model which allows for pair creation. (auth)

46803 ELECTRODYNAMICS OF DIRECT INTERPARTICLE ACTION. I. THE QUANTUM MECHANICAL RESPONSE OF THE UNIVERSE. Hoyle, F.; Narlikar, J. V. (Cambridge Univ., Eng.). Ann. Phys. (N. Y.), 54: 207-39(Sept. 1969).

Results in agreement with experience from a completely time-symmetric electromagnetic theory are sought—i.e., which does not permit an ad hoc restriction to retarded solutions of time-symmetric equations. While a first quantization of the particles can readily be carried out, there can be no separate quantization of the field, since the field is wholly determined by the particles. This raises the question of how practical results that have hitherto been thought to arise from field quantization can be obtained. The most immediate problem of this kind concerns the spontaneous transitions of atoms. It is shown that this problem can indeed be solved without the need for field quantization. Although this question might appear simple compared to other issues in quantum electrodynamics—e.g., vacuum polarization—it is not trivial in its implication, for the establishment of one such case provides a critical precedent. The path integral method of first quantization is used to demonstrate that provided the universe is a perfect absorber along the future light cone the usual formulas for level shifts and for spontaneous transitions can be obtained in a steady-state model of the universe, but not in open Friedmann models. (auth)

46804 FUNCTIONAL QUANTUM THEORY OF SCATTERING PROCESSES. [PART] I. Stumpf, H. (Univ., Tuebingen, Ger.). Z. Naturforsch., 24a: 1022-9(June 1969).

Dynamics of quantum field theory can be formulated by functional equations. To develop a complete functional quantum theory one has to describe the physical information by functional operations. One of the most important physical quantities of elementary particle physics is the S-matrix. To derive a functional expression for this quantity the potential scattering model is studied. A functional S-matrix is defined and its equivalence with the ordinary S-matrix definition in physical Hilbert space is proven. Also a calculational method for scattering functionals is proposed. (auth)

46805 VARIATIONAL FORMULATION OF QUANTUM FIELD THEORY. II. A STUDY OF A FUNCTIONAL DERIVATIVE EQUATION RELATED TO THE gA^3 THEORY. Dahmen, H. D. (Univ. Heidelberg); Jona-Lasinio, G. Contract F61052 67 C 0084., Nuovo Cim., 62A: 889-924(Aug. 21, 1969).

A linear functional differential equation determining in the weak-coupling limit, the self-energy as a functional of the dressed propagator in the gA^3 theory is studied. This equation follows from an exact equation derived in the first paper of this series. The study is carried through by substituting a lattice of points for the four-dimensional space-time continuum. The equation then reduces to a system of partial-differential equations with nonconstant coefficients. The structure of the system is analyzed in detail and the conclusion is reached that only a subset of the equations must be considered as partial differential equations, the remaining ones having only algebraic content. The solutions satisfying the further constraints of symmetry and translational invariance are then constructed. For this class of solutions the system collapses into a system of ordinary differential equations. This essential simplification allows the construction of explicit solutions which exhibit an essential singularity for vanishing value of the coupling constant. The divergent perturbation solution of the system can be obtained from the exact solution using a straightforward procedure, which supplies an explicit expression for the remainder of the series. One then sees that under appropriate restrictions on the propagator matrix the perturbation expansion can be asymptotic to the exact solutions. The propagators allowed under these restrictions do not necessarily represent physically meaningful propagators. There is, however, a different expansion for the solutions which converges for any value of g^2 different from zero under mild restrictions on the propagator matrix. The question of which of the conclusions valid for the lattice can be extended to the four-dimensional space-time continuum is not investigated. (auth)

46806 THE TORSIONLESS AFFINE FIELD THEORY OF EINTEIN. Gilbert, C. (Univ. of Newcastle upon Tyne, Eng.). J. Phys., A (London), 2: 509-20(Sept. 1969).

The affine field theory of a symmetric connection is based on a more general variational principle than was used by Einstein. The action density is a function of the Ricci tensor and a covariant vector field A_i, which is determined by the connection. The terms in the field equations which depend explicitly on A_i are interpreted as charge-current 4-vectors. The field equations give a generalization of Mie's theory of electrodynamics, and in a special case they correspond to Born's non-linear equations of electrodynamics. A connection with Maxwell's equations is also established in this case. The static spherically symmetric field of an electron is described, and an interpretation of the solutions, which ascribes a structure to the electron, is briefly discussed. (auth)

46807 DEFINITION OF LOCAL OBSERVABLES IN QUANTUM FIELD THEORY. Capri, A. Z. (Univ. of Alberta, Edmonton). Nuovo Cim., 63B: 236-40(Sept. 11, 1969).

The problem of how to define a local observable in quantum field theory is reconsidered. It is shown that the additive c-number in the definition is uniquely determined by either a physical or mathematical assumption on the vacuum state. The two assumptions yield the same result. (auth)

46808 VERTEX FUNCTIONS AT LARGE MOMENTUM TRANSFER. I. EXPONENTIAL DECREASE OF THE WU-YANG TYPE. Minami, Masatsugu (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 42: 82-107(July 1969).

A discussion is given of the asymptotic behavior of the vertex function at large momentum transfer in the framework of relativistic field theory. The discussion makes use of the Jost-Lehmann-Dyson representation, and the vertex function is shown to fall off exponentially if an attempt is made to transform the weight function by a Hankel inverse formula and introduce appropriately a constant $\rho_0 > 0$. An attempt is also made on similar grounds to deduce the exponential decrease of the absorptive part of the vertex function for large time-like momentum. It is finally suggested that the presence of nonzero ρ_0, which has the dimension of length squared, implies a violation of customary locality. (auth)

46809 COMPOSITE PARTICLES WITH THE REGGE MASS SPECTRUM. Watanabe, Tadashi; Miyazaki, Tadashi (Tokyo Univ.). Progr. Theor. Phys. (Kyoto), 42: 121-4(July 1969).

The field equations of the particles on the nucleon trajectory are discussed and the physical Lorentz group is found to be the extracted O(3,1) subgroup of the direct product of $O_{orb}(3,1) \times O_s(3,1) \times O_{s'}(3,1) \times O_{in}(3,1)$. (auth)

46810 RELATIVISTIC INTERACTION OF CLASSICAL PARTICLES. Wigner, E. P. (Princeton Univ., N. J.). pp 344-61 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy Coral Gables, Fla. See CONF-690110.

A relativistic invariant theory of interacting point particles where the masses are constants and the conservation laws are satisfied is developed. The development of an analogous quantum theory is also discussed. (L.B.S.)

46811 EUCLIDEAN QUANTUM FIELD THEORY. Symanzik, K. (DESY, Hamburg). pp 19-32 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

The analytic Wightman functions restricted to Schwinger points are studied in Euclidean quantum field theory of a nonhermitian

scalar field. It is found that relatively efficient mathematical tools are available for studying these functions that have no counterpart in the case of the respective real-time Wightman Green's functions. (L.B.S.)

46812 PHASE FACTORS IN DISCRETE SYMMETRY OPERATIONS IN QUANTUM FIELD THEORY. de Graaf, T.; Tolhoek, H. A. (Univ., Groningen, Netherlands). Physica, 43: 142-64 (July 1, 1969).

A study is made of the phase factors which may occur when one represents the extended reflection group G_Θ (the transformations P, C and T and their products) in the quantum theory of fields. When considering free fields these phase factors may be restricted to certain values by asking a maximum in mathematical simplicity of the obtained representation. The phase factors obtained with this mathematical criterion may be compared to the phase factors which one obtains for a theory with interacting fields. For interacting fields a definition of invariance under discrete symmetry operations is proposed, and also a criterion is discussed which seems largely equivalent to it. The criterion provides, when satisfied, a compatible system of equations for the phase factors with which the field operators transform. The solutions of these equations are the intrinsic phase factors of the fields. Certain interactions can be given, where these phase factors do not agree with those according to the mathematical criterion. However, such interactions have not been found in nature until now. (auth)

46813 AN EXACT QUANTUM THEORY OF THE TIME-DEPENDENT HARMONIC OSCILLATOR AND OF A CHARGED PARTICLE IN A TIME-DEPENDENT ELECTROMAGNETIC FIELD. Lewis, H. R. Jr.; Riesenfeld, W. B. (Los Alamos Scientific Lab., N. Mex.). J. Math. Phys. (N.Y.), 10: 1458-73 (Aug. 1969).

The theory of explicitly time-dependent invariants is developed for quantum systems whose Hamiltonians are explicitly time dependent. The central feature of the discussion is the derivation of a simple relation between eigenstates of such an invariant and solutions of the Schrödinger equation. As a specific well-posed application of the general theory, the case of a general Hamiltonian which settles into constant operators in the sufficiently remote past and future is treated and, in particular, the transition amplitude connecting any initial state in the remote past to any final state in the remote future is calculated in terms of eigenstates of the invariant. Two special physical systems are treated in detail: an arbitrarily time-dependent harmonic oscillator and a charged particle moving in the classical, axially symmetric electromagnetic field consisting of an arbitrarily time-dependent, uniform magnetic field, the associated induced electric field, and the electric field due to an arbitrarily time-dependent uniform charge distribution. A class of explicitly time-dependent invariants is derived for both of these systems, and the eigenvalues and eigenstates of the invariants are calculated explicitly by operator methods. The explicit connection between these eigenstates and solutions of the Schrödinger equation is also calculated. The results for the oscillator are used to obtain explicit formulas for the transition amplitude. The usual sudden and adiabatic approximations are deduced as limiting cases of the exact formulas. (auth)

46814 ASYMPTOTIC FIELDS OF THE LEE MODEL. Jernow, Stanley; Kazes, Emil (Pennsylvania State Univ., University Park). J. Math. Phys. (N.Y.), 10: 1326-39 (Aug. 1969).

The field equations for the Lee model are solved by constructing eigenfields from the most general possible combination of bare fermion and boson operators. These solutions are found to require an infinite number of boson terms, the coefficients of which obey the integral equations of scattering theory. It is discovered that the algebra of the Lee-model fermion eigenfields is not that of free particle operators. The anticommutator of the ith fermion eigenfield $A_i^\dagger$ has the form $\{A_i, A_i^\dagger\}_+ = 1 - \Sigma_{j \neq i} A_j^\dagger A_j$, where the sum is over all other fermion eigenfields. An algebra of this type is not peculiar to the Lee model. It will hold for all fields which obey a general Pauli exclusion principle and which are orthogonal to one another. The explanation for this algebra lies in the fact that these eigenfields represent operators which create states and not particles. Several other models exhibiting this same behavior (including the harmonic oscillator) are presented; for these models boson fields may also be constructed which have the above algebra. The asymptotic convergence of these eigenfields is not examined. However, it is found that all such Lee-model fermion fields, including those constructed by the Yang–Feldman method, must satisfy the above algebra and do not enjoy a free-fermion canonical algebra. (auth)

46815 RECIPROCITY PRINCIPLE AND THE LORENTZ TRANSFORMATIONS. Berzi, Vittorio; Gorini, Vittorio (Univ., Milan, Istituto Nazionale di Fisica Nucleare, Milan). J. Math. Phys. (N.Y.), 10: 1518-24 (Aug. 1969).

By using the principle of relativity, together with the customary assumptions concerning the nature of the space-time manifold in special relativity, namely, space-time homogeneity and isotropy of space, a simple but rigorous proof is given of the reciprocity relation for the relative motion of two inertial frames of reference, which is usually assumed as a postulate in the standard derivations of the Lorentz transformations without the principle of invariance of light velocity. A critical discussion is set forth of the question of eliminating the transformations with invariant imaginary velocity, which one unavoidably obtains together with the Lorentz transformations and the Galilean ones in adopting a procedure of this kind. (auth)

46816 PARTIAL SUMS OF VACUUM POLARIZATION GRAPHS. Fink, James P. (Univ. of Pittsburgh). J. Math. Phys. (N.Y.), 10: 1440-1 (Aug. 1969).

Results on the logarithmic asymptotic behavior of certain partial sums of photon self-energy graphs are presented. (auth)

46817 EQUAL-TIME PSEUDOLIMITS OF CURRENT COMMUTATORS AND SCHWINGER TERMS. Otterson, Paul (Univ. of Maryland, College Park). J. Math. Phys. (N.Y.), 10: 1525-30 (Aug. 1969).

The equal-time limits of some current commutators are studied in perturbation theory. Although the orthodox equal-time limit does not exist as a distribution, a Schwinger term may be defined as a pseudolimit—a continuous linear functional on a proper subspace of $S(R^3)$. The results are compared with those obtained from alternative approaches. Simple examples are given to explain why these methods give incorrect results for the cases considered. (auth)

Gravitation and General Relativity

Refer also to abstracts 46167 and 46223.

46818 QUANTIZED FIELDS AND PARTICLE CREATION IN EXPANDING UNIVERSES. I. Parker, Leonard (Univ. of Wisconsin, Milwaukee). Phys. Rev., 183: 1057-68 (July 25, 1969).

Spin-0 fields of arbitrary mass and massless fields of arbitrary spin are considered. The equations governing the fields are the covariant generalizations of the special-relativistic free-field equations. The metric, which is not quantized, is that of a universe with an expanding (or contracting) Euclidean 3-space. The spin-0 field of arbitrary mass is quantized in the expanding universe by the canonical procedure. The quantization is consistent with the time development dictated by the equation of motion only when the boson commutation relations are imposed. This consistency requirement provides a new proof of the connection between spin and statistics. It is shown that the particle number is an adiabatic invariant, but not a strict constant of the motion. An expression is obtained for the average particle density as a function of the time, and it is shown that particle creation occurs in pairs. The canonical creation and annihilation operators corresponding to physical particles during the expansion are specified. Thus, an S-matrix approach is not used. It is shown that in a universe with flat 3-space containing only massless particles in equilibrium, there will be precisely no creation of massless particles as a result of the expansion, provided the Einstein field equations without the cosmological term are correct. Furthermore, in a dust-filled universe with flat 3-space there will be precisely no creation of massive spin-0 particles in the limit of infinite mass, again provided that the Einstein field equations are correct. Conversely, without assuming any particular equations, such as the Einstein equations, as governing the expansion of the universe, the familiar Friedmann expansions are obtained for the radiation-filled and the dust-filled universes with flat 3-space. Only a very general and natural hypothesis is made connecting the particle creation rate with the macroscopic expansion of the universe. In one derivation, it is assumed that in an expansion of the universe in which a particular type of particle is predominant, the type of expansion approached after a long time will be such as to minimize the average creation rate of that particle. In another derivation, the assumption is used that the reaction of the particle creation back on the gravitational field will modify the expansion in such a way as to reduce, if possible, the creation rate. This connection between the particle creation and the Einstein equations is surprising because the Einstein equations themselves played no part at all in the derivation of the equations governing the particle creation. Finally, on the basis of a so-called infinite-mass approximation, it is argued that in the present predominantly dust-filled universe, only massless particles of

zero spin might possibly be produced in significant amounts by the present expansion. In this connection, it is shown that massless particles of arbitrary nonzero spin, such as photons or gravitons, are not created by the expansion, regardless of its form. (auth)

46819 GRAVITATIONAL FIELD OF A DISK. Morgan, Thomas; Morgan, Lesley (Univ. of Nebraska, Lincoln). Phys. Rev., 183: 1087-1101(July 25, 1969).

The general solution of the static field equations of general relativity is given for a disk of "counter-rotating" dust particles. The only nonvanishing components of the energy-momentum tensor are T^3_3 and T^4_4, which are assumed to have δ-function singularities on the disk. Two representative families of solutions are considered, and it is shown that, for these solutions, physical considerations severely limit the strength of the gravitational potentials. The first family has surface density proportional to some power of $1-\rho^2$. The requirement that the velocity of the dust particles should not exceed c places a bound on the gravitational red-shift of z = 1.5803 for these models. The second family is that of the uniformly rotating disks defined by $v^2 = \rho^2\omega^2 e^{-4\Phi}$. Bardeen has pointed out that these disks can have arbitrarily large red-shifts without violating the velocity condition. However, it is shown that their red-shift cannot exceed 1.9015 before their binding energy becomes negative. This work suggests that the largest gravitational red-shift to which counter-rotating dust disks can give rise is of order of magnitude 1. (auth)

46820 YILMAZ' THEORY OF GRAVITATION AND SOME MODIFICATIONS. Tupper, B. O. J.; Page, C. (Univ. of Exeter, Eng.). J. Phys., A (London), 2: 521-8(Sept. 1969).

An apparent error in the formulation of Yilmaz' (Phys. Rev., 111: 1417-26(1958)) theory of gravitation is corrected. Yilmaz' field equations are unaffected, but the corrected theory suggests alternative field equations. (auth)

46821 FLAT-SPACE METRIC IN THE QUATERNION FORMULATION OF GENERAL RELATIVITY. Marcio do Amaral, C.; Oliveira, C. G. (Centro Brasileiro de Pesquisas Fisicas, Rio de Janeiro). Nuovo Cim., 63B: 318-30(Sept. 11, 1969).

Using the quaternion representation of the Riemannian space-time of general relativity the description of the gravitational field in flat space is formulated. The method presently used is an extension for the quaternion fields of a formalism introduced by Rosen. The theorem of quasi-inertia is established. The equations of the gravitational field are obtained in terms of spinors which are functions of quaternions defined on the flat space. The equation of motion of a test particle is also obtained. (auth)

46822 GRAVITATIONAL COUPLING OF NEGATIVE MATTER. Inomata, A.; Peak, D. (State Univ. of New York, Albany). Nuovo Cim., 63B: 132-42(Sept. 11, 1969).

The relevance of the sign of mass in general relativity is examined by analyzing a simple model universe in which Dirac matter is distributed uniformly. Mass reversal, converting a source of positive matter into one of negative matter, gives rise to a concomitant change in sign of the gravitational coupling. The principle of equivalence is invoked in order to generalize the result of all negative-matter sources. The admissibility of a Dirac source in general relativity implies that the sign of mass is irrelevant in gravitational interactions. (auth)

46823 GRAVITATIONAL INTERACTIONS AT HIGH ENERGY. Weber, Joseph (Univ. of Maryland, College Park). pp 312-23 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

A review is given of some developments of the last twenty years toward a quantum theory of gravitation. The development of experimental techniques and apparatus to search for gravitational waves is briefly discussed. (L.B.S.)

46824 DETERMINATION OF THE GRAVITATIONAL CONSTANT G. Rose, R. D.; Parker, H. M.; Lowry, R. A.; Kuhlthau, A. R.; Beams, J. W. (Univ. of Virginia, Charlottesville). Phys. Rev. Lett., 23: 655-8(Sept. 22, 1969).

A new method for measuring the gravitational constant G is described. Preliminary measurements give $G = (6.674 \pm 0.012) \times 10^{-11}$ N m^2/kg^2 where the 0.012 represents 3 standard deviations. Furthermore there is reason to believe that with certain modifications of the apparatus and use of improved metrology techniques an increase in precision of at least one and probably two orders of magnitude will be obtained. (auth)

46825 MASSIVE GRAVITONS. Freund, Peter G. O. (Univ. of Chicago). pp 304-11 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

A theory of massive gravitons is outlined. It is required that the source of gravitation be the energy-momentum tensor. At a local level the theory is indistinguishable from Einstein's theory. Cosmologically it is distinct from Einstein's theory and leads to a universe in which the cosmological frequency shift as a function of time oscillates between two finite bounds. The geometrical interpretation is abandoned while still offering a dynamically complete scheme. (L.B.S.)

46826 INITIAL CONDITIONS IN GENERAL RELATIVITY: LAPSE AND SHIFT FORMULATION. Belasco, Elliot P.; Ohanian, Hans C. (Princeton Univ., N. J.). J. Math. Phys. (N.Y.), 10: 1503-7(Aug. 1969).

The system of coupled differential equations to which the constraints on the Cauchy data reduce if expressed in terms of the "shift" vector N_k and "lapse" N_0 are examined. If ${}^{(3)}g_{ij}$ and $\partial {}^{(3)}g_{ij}/\partial t$ are given and Dirichlet boundary conditions are imposed, the solution N_k is found to be unique if $2 \times$ (energy density) $-$ (three-curvature) >0, but need not be unique when this inequality is not satisfied. No general existence theorem is known, but some conditions which make solutions impossible are listed. (auth)

46827 REMARK ON NONINVARIANCE GROUPS AND FIELD QUANTIZATION IN CURVED SPACE. Urbantke, H. K. (Univ., Vienna). Nuovo Cim., 63B: 203-14(Sept. 11, 1969).

It is investigated under what conditions quantized fields on curved space-time yield representations of a group of transformations of the space-time manifold. (auth)

Scattering Theory

Refer also to abstracts 46639, 46690, 46747, 46748, 46789, 46804, and 46814.

46828 A NON-ANALYTIC S-MATRIX. Cutkosky, R. E.; Landshoff, P. V.; Olive, D. I.; Polkinghorne, J. C. (Cambridge Univ., Eng.). Nucl. Phys., B12: 281-300(1969).

A study is made of theories having the unusual analyticity properties recently proposed by Lee and Wick. A prescription is given for setting up a covariant perturbation-theory expansion of the scattering amplitudes, based on Feynman graphs. It is found that in the presence of a complex pole in the upper half plane of the physical sheet leads to points of non-analyticity in the physical region, such that the values of the amplitude to either side of the point are not related by analytic continuation. It is shown how this is compatible with unitarity. The nature of the non-analyticity is not fully determined by unitarity. Neither, in the case of the more complicated graphs, is it fully determined by the perturbation-theory prescription, and some extra constraint must be imposed on the theory to remove the ambiguity. It is shown that the prescription of Lee and Wick has an exactly similar ambiguity, but for their prescription different results are obtained in different Lorentz frames. An estimate is made of the extent to which the theory violates causality, and is found to be too small to measure. (auth)

46829 S-MATRIX IN HYPERQUANTIZATION. Takahashi, Yasushi; Gourishankar, Radha (Univ. of Alberta, Edmonton). Nucl. Phys., B12: 301-21(1969).

The S-matrix is studied in detail in a hyperquantization method previously formulated. Relativistic invariance of the S-matrix is proved. Reduction formulas analogous to those in the LSZ theory are also derived. (auth)

46830 LORENTZ POLE ANALYSIS OF VENEZIANO AMPLITUDES. Olesen, P.; Rashid, M. A. (Univ. of Rochester, N. Y.). Nucl. Phys., B12: 322-4(1969).

A very general argument is presented showing that any amplitude, built up from a finite number of beta functions corresponds to an infinite number of Lorentz poles. A single Lorentz pole can be generated by superposition of an infinite number of such functions. This superposition, however, is not unique. (auth)

46831 REGGE BEHAVIOUR AND A LOWER BOUND FOR THE DECREASE OF THE SCATTERING AMPLITUDE. Nguyen Ngoc Thuan (Joint Inst. of Nuclear Research, Dubna, USSR). Nucl. Phys., B12: 426-32(1969).

Lower bounds for the scattering amplitude at fixed t are derived on the basis of analytical properties of the amplitude in t. It is shown that the cross section cannot approach zero faster than Regge theory predicts. Lower bounds for the Regge trajectories are obtained. (auth)

46832 EIKONAL EXPANSION. Sugar, R. L.; Blankenbecler, R. (Univ. of California, Snata Barbara). Phys. Rev., 183: 1387-96(July 25, 1969).

A systematic study is made of high-energy scattering in nonrelativistic quantum mechanics. Approximate amplitudes are obtained for the scattering of a high-energy projectile off a single particle and off a compound system. The results hold for all momentum transfers. Near the forward direction, they reduce to the well-known Glauber formulas, and for large momentum transfers, the leading terms are seen to correspond to the Mandelstam-cut diagrams. (auth)

46833 SYSTEMATIC CLASSIFICATION OF PHASE CONTOURS AND ZEROS. Kaiser, G. D. (Cambridge Univ., Eng.). Phys. Rev., 183: 1499-1505(July 25, 1969).

A systematic classification of phases contours and zeros is introduced and their effect on asymptotic behavior investigated. A constraint is found on the spacing of closed contours if they are not to contribute to asymptotic behavior. Use is made of a theorem due to Pólya and Szegö about entire functions with real negative zeros. The concept of topological equivalence of phase contour maps is discussed. The theorem due to Pólya and Szegö is applied to the fixed-angle scattering amplitude with the assumption that certain kinds of contours or zeros dominate; this leads to a constraint on the order of the entire function by which the amplitude may be approximated. (auth)

46834 PHASE OF THE LARGE-ANGLE SCATTERING AMPLITUDE AND VAN HOVE'S UNCORRELATED JET MODEL. Kaiser, G. D. (Univ. of Miami, Coral Gables, Fla.). Phys. Rev., 183: 1506-10(July 25, 1969).

By considering the s plane at fixed $A = [(1 - \cos\theta)/(3 + \cos\theta)]^2$, where θ is the c.m. scattering angle, it is shown that the phase of the crossing-symmetric amplitude that describes the large-angle elastic scattering of spinless particles is energy-dependent, for almost all possible phenomenologically based assumptions about the high-energy behavior of the differential cross section. The consequences for the uncorrelated jet model are discussed. The work is extended to particles with spin. (auth)

46835 ANALYSIS OF A SCATTERING PROCESS WITH SPIN IN THE INFINITE-MOMENTUM FRAME. Chang, N. P. (City Coll., New York); Raman, K. Phys. Rev., 183: 1446-51(July 25, 1969).

A kinematical analysis is made of a two-particle scattering process with arbitrary spin in an infinite-momentum frame. It is shown how the description of the spin, in particular, can be simplified by going to this frame. The scattering amplitude is expressed as a function over an E(2) algebra in the infinite-momentum frame; this immediately leads to an impact-parameter representation of the amplitude for arbitrary spin. This representation is different from the fixed-energy impact-parameter representation; in particular, the unitarity relation, in the two-body approximation, is seen to have a simple form. (auth)

46836 THEORY OF THE SCATTERING OPERATOR. I. PRELIMINARY FORMULATION. Rohrlich, F. (Syracuse Univ., N. Y.). Phys. Rev., 183: 1359-71(July 25, 1969).

The theory developed is physically an S-matrix theory but mathematically a (non-Lagrangian) quantum field theory. It is related to the Lehmann-Symanzik-Zimmermann approach, but does not involve an asymptotic condition, since it does not involve an interpolating field. Using only the asymptotic free fields and assumptions on unitarity and causality, an equation is derived for the S operator whose solutions are both unitary and causal. An operator in this equation which is partly arbitrary indicates the freedom left for specifying the interaction. The theory does not involve renormalizations unless more than one interaction is involved and certain approximations are made. The solution of the S-operator equation can be accomplished in perturbation expansion. (auth)

46837 GENERALIZATIONS OF THE VENEZIANO AND VIRASORO MODELS. Mandelstam, S. (Univ. of California, Berkeley). Phys. Rev., 183: 1374-86(July 25, 1969).

It is suggested that Virasoro's fixed poles in the j plane of the Veneziano amplitude should be regarded as Gribov–Pomeranchuk poles. The third Veneziano term can probably have other effects associated with a third double-spectral function, such as cuts in the angular-momentum plane. The alternative to the Veneziano formula proposed by Virasoro may therefore not conflict with unitarity. A generalized formula is proposed which contains the Veneziano and Virasoro amplitudes as special cases. The new formula has a double-integral representation which is similar to the beta-function representation for the Veneziano formula. Another generalization of the Veneziano formula is proposed, in which the signature degeneracy can be broken by an arbitrary amount. (auth)

46838 HELICITY CROSSING MATRIX FOR PRODUCTION PROCESSES. Chen, Chih Kwan; Wang, Kuo-hsiang (Univ. of California, Berkeley). Phys. Rev., 183: 1312-7(July 25, 1969).

The crossing matrix of the helicity amplitude for a production process is worked out with the conventional definition of helicity states. This crossing matrix has the same form in different c.m. frames except for particles moving along the z axis, which have additional phases. It can thus be used for successive crossings. The generalization to N-to-N′ processes is discussed, and application to the Regge formalism is considered. (auth)

46839 UNITARITY AND THE VENEZIANO REPRESENTATION. Arbab, Farzam (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 183: 1207-12(July 25, 1969).

The conjecture that simple Veneziano-type formulas represent the zeroth-order approximation to certain strong-interaction amplitudes is investigated. With Imα as a small parameter, the question of incorporating unitarity to next order is studied, and a simple example illustrating some of the features is constructed. The problem is posed in terms of partial-wave amplitudes; therefore, the partial-wave projection of the Veneziano formula is also discussed in some detail. (auth)

46840 EXTENSION AND APPLICATION OF A RECENT ANSATZ CONCERNING THE P′ RESIDUE FUNCTION. Goldberg, Hyman (Northeastern Univ., Boston). Phys. Rev., 183: 1213-14(July 25, 1969).

A modification of the Barger-Phillips ansatz is proposed for the P′ residue function and is used in conjunction with a previous result from dispersion theory, to demonstrate an interesting consistency in the identification of the $f^0(1260)$ as the first particle on the phenomenological P′ trajectory. (auth)

46841 KINEMATIC PROPERTIES OF HELICITY AMPLITUDES. Raynal, J. C. (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nuovo Cim., 62A: 864-80 (Aug. 21, 1969).

The following problem is solved: given the hypothesis of analyticity about spinor amplitudes, find an equivalent set of properties about helicity amplitudes. The method used is a rather direct one; the sets of properties gotten are not new, except for $\Phi(s,t) = 0$, when the hypothesis of saturation of the analyticity domain of the spinor amplitude is removed. (auth)

46842 ENERGY POLES FROM INFINITE DAUGHTER SERIES. Jacob, M. (CERN, Geneva); Mandelbrojt, J. Nuovo Cim., 63A: 279-84(Sept. 1, 1969).

An infinite sequence of Regge poles can be identified with a Dirichlet series. A theorem which applies to these series is used to connect energy poles to asymptotic trajectory density. Limitations on the asymptotic density are obtained, a result of interest in view of present considerations of models based on infinite daughter series. (auth)

46843 UNIFIED TREATMENT OF REGULARIZED HELICITY AMPLITUDES FOR ARBITRARY SPINS. King, M. J. (Johns Hopkins Univ., Baltimore). Nuovo Cim., 63A: 238-60(Sept. 1, 1969).

A new set of regularized helicity amplitudes, that is, linear combinations of helicity amplitudes which are free of kinematic singularities, are defined and have certain advantages over those previously defined. The most useful advantage is a unified prescription for each mass configuration independent of the spins of the particles. Constraint equations at pseudothresholds and conspiracy relations at $s = 0$ are given in terms of the regularized helicity amplitudes. It is shown that if both of the initial (or final) particles have either integral or half-integral spins, threshold constraint equations in the unequal-mass case relate amplitudes of the same dominant parity. If one of the initial particles has integral and the other has half-integral spin, in the limit of large t, the unequal-mass constraint equations involve amplitudes of the same dominant parity. Analyticity in the mass variables is considered, and the smooth transition from unequal to equal masses for regularized helicity amplitudes is demonstrated. (auth)

46844 THEORY OF REPRESENTATION OF SCATTERING DATA BY ANALYTIC FUNCTIONS. Cutkosky, R. E. (Cambridge Univ., Eng.). Ann. Phys. (N. Y.), 54: 350-78(Sept. 1969).

An extension is presented of a recently developed new method for analysis of differential cross section data. The method is designed to be the most powerful possible, given certain information about the relative degree of variability of the scattering amplitude. It is also designed to give a conservative estimate of systematic errors. The method is based on earlier work by Cutkosky and Deo and by Ciulli, and uses an expansion in terms of functions which are especially adapted both to the assumed analyticity properties and to the characteristics of the data. The amplitude is characterized, in addition to having a given analyticity domain, by a weighted Gaussian measure over the set of possible boundary values. For a given weight, for a given set of data, and for given parameters which are related linearly to the amplitude, there is a definite construction which will lead to the best convergence properties. The construction also provides a definite prescription for the form factors associated with poles. A test function, based on ratios of expansion coefficients, is constructed for the purpose of estimating truncation errors and the truncation point, and for distinguishing among various fits to the data. This test function is similar to χ^2 and is to be used in conjunction with χ^2 in analyzing data. (auth)

46845 A REPRESENTATION OF PARTIAL WAVES FOR SUPERPOSITIONS OF YUKAWA POTENTIALS TOGETHER WITH A COULOMB POTENTIAL. Andrews, M. (Australian National Univ., Canberra). Nuovo Cim., 63A: 129-34(Sept. 1, 1969).

Martin's representation of wave functions for Yukawa-like potentials is modified to cover the case of a superposition of Yukawa potentials together with an additional Coulomb potential. The method can be applied to partial-wave functions in scattering where the Coulomb part is either attractive or repulsive, but for bound-state wave functions the Coulomb part must be repulsive. (auth)

46846 ON THE PROPOSITION GIVEN BY T. T. WU CONCERNING THE EXPONENTIAL DECREASE OF THE HIGH-ENERGY LARGE-ANGLE DIFFERENTIAL CROSS SECTION. Minami, Masatsugu; Miyata, Hideo; Yabuki, Haruichi (Kyoto Univ.). Progr. Theor. Phys. (Kyoto), 42: 108-15(July 1969).

T. T. Wu's postulate for the vertex function proposed to reproduce the exponential decrease of the high-energy large-momentum-transfer cross section is studied in terms of the Jost–Lehmann–Dyson representation, its weight function being adjusted appropriately in a large momentum region. (auth)

46847 ON THE GROUP-THEORETICAL APPROACH TO THE CONSPIRACY PROBLEM FOR ARBITRARY MASSES. II. Cosenza, C. (Univ., Naples. Univ., Rome); Sciarrino, A.; Toller, M. Nuovo Cim., 62A: 999-1025(Aug. 21, 1969).

Using the technique developed in the first part of this work, a large class of families of conspiring Regge trajectories are constructed, which satisfy all the constraints of analyticity and factorization in a region of the momentum-transfer complex plane including the origin and the pseudothresholds. Equal- and unequal-mass reactions are treated in a unified way. Particles with arbitrary spins and parities are considered. The formalism automatically suggests a kind of LS coupling scheme and gives rise to the right pseudothreshold factors. The pseudothreshold and the small-momentum-transfer behaviors of the Regge residues are given for all the daughter trajectories. The spin dependence of the high-energy forward-scattering amplitude is studied in detail. (auth)

46848 ON THE DEGENERACY OF REGGE TRAJECTORIES IMPOSED BY THE VENEZIANO-TYPE AMPLITUDE. Imachi, Masahiro; Kinoshita, Kisei; Shiga, Kunio; Toyoda, Fumihiko; Uehara, Masayuki (Kyushu Univ., Fukuoka). Progr. Theor. Phys. (Kyoto), 42: 128-9(July 1969).

Some defects of the Veneziano-type amplitude with no satellite terms are pointed out, some of which would enforce serious modification of the model. These include the absence of $\pi\Sigma$ scattering, $\rho^0 - \omega$ mass degeneracy, extra spin-parity degeneracy of baryon resonances, and exchange degeneracy. (L.B.S.)

46849 APPLICATION OF DISPERSION SUM RULES TO NON-FORWARD HIGH-ENERGY SCATTERING. Solov'ev, L. D. (Inst. for High Energy Physics, Serpukhov, USSR). pp 220-9 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

A method of obtaining the qualitative estimation of Regge pole parameters for the spin-flip amplitudes and for non-zero momentum transfers from dispersion sum rules is presented. The spin-flip pion-nucleon scattering amplitude is considered as an example. (L.B.S.)

46850 AN ALGEBRAIC APPROACH TO THE RELATIVISTIC TWO-BODY PROBLEM. Itzykson, C.; Todorov, I. T. (Inst. for Advanced Study, Princeton, N. Y.). pp 33-68 of Fundamental Interactions at High Energy. Gudehus, Timm; Kaiser, Geoffrey; Perlmutter, Arnold (eds.). New York, Gordon and Breach, 1969.

From Conference on Fundamental Interactions at High-Energy, Coral Gables, Fla. See CONF-690110.

The "hydrogen-type" ladder representation of SU(2,2) is realized in the space of functions on the two-sheeted hyperboloid $k^2 = m^2$ in such a way that the 4-momentum of k of a free spinless particle is expressed as a function of the generators by $k_\mu = m\Gamma_5^{-1}\Gamma_\mu$. In the case when the interaction V originates from the exchange of a massless scalar particle (the "scalar Coulomb interaction"), the resulting algebraic equation is solved exactly. It is shown to exhibit an O(4) symmetry just like the non-relativistic Coulomb problem. (auth)

46851 PRESENT STATUS OF THE PHENOMENOLOGICAL REGGE POLE THEORY. II. Bando, Masako; Morita, Katsusada; Yoshida, Toshihiro (Kyoto Univ.). Mem. Fac. Sci., Kyoto Univ., Ser. Phys., Astrophys., Geophys., Chem., 33: 55-93(Oct. 1968).

Most recent developments in various fields of phenomenological Regge pole theory of high energy scattering are reviewed. (auth)

46852 UNIQUENESS OF THE VENEZIANO REPRESENTATION. Coon, D. D. (Univ. of Washington, Seattle). Contract AT(45-1)-1388. Phys. Lett., 29B: 669-72(Aug. 18, 1969).

Infinite product representations possessing meromorphy in s and t as well as polynomial residues are investigated. The representations found turn out to have Regge behavior and nonlinear trajectories and to include the Suzuki-Veneziano form as a limiting case. (auth)

46853 SOLUTION OF THE BETHE–SALPETER EQUATION FOR BOUND STATES. [PART] I. zur Linden, E. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 63A: 181-92(Sept. 1, 1969).

A complete numerical solution of the scalar Bethe-Salpeter equation in the ladder approximation is obtained for arbitrary masses of the constituent particles and arbitrary total energy. The Regge trajectories exhibit characteristic differences for the cases of equal and unequal external masses. (auth)

46854 SOLUTION OF THE BETHE–SALPETER EQUATION FOR BOUND STATES. [PART] II. zur Linden, E. (Max-Planck-Institut fuer Physik und Astrophysik, Munich). Nuovo Cim., 63A: 193-202(Sept. 1, 1969).

A complete set of solutions of the Wick–Cutkosky model is obtained in the form of an expansion in powers of the total energy, the coefficients of which can be determined to arbitrary order. The Regge trajectories are calculated. (auth)

46855 ON THE ADIABATIC APPROACH TO THE WAVE MATRIX IN A LEE MODEL. Becchi, C. M.; Dillon, G.; Passatore, G. (Univ., Genoa. Istituto Nazionale di Fisica Nucleare, Genoa). Nuovo Cim., 63A: 315-42(Sept. 1, 1969).

The definition of the Möller wave matrix is discussed in a scattering problem, where the unperturbed Hamiltonian has discrete eigenvalues. It is shown rigorously for a Lee model that the wave matrix, obtained by switching off the interaction in a suitable way at $t = -\infty$, gives in the limit of no switching a unitary wave matrix, which diagonalizes the Hamiltonian. So it is verified that the adiabatic approach is the correct one in this case, where the usual definition of the wave matrix, as $\lim_{t\to-\infty} \exp[iHt] \exp[-iH_0t]$, gives no definite result. Some possible extensions of this procedure are examined together with the connection of these results with the problem of defining asymptotic states in the field theory. (auth)

46856 SOLUTION OF THE FADDEEV EQUATION FOR LOCAL POTENTIALS BY APPROXIMATE PRODUCT-INTEGRATION. Kim, Y. E. (Purdue Univ., Lafayette, Ind.). J. Math. Phys. (N.Y.), 10: 1491-4(Aug. 1969).

A practical method of solving the Faddeev equation for short-range local potentials is proposed. The method consists of transforming the Faddeev equation into a form in which the inhomogeneous term satisfies a Hölder condition and then solving the resultant two-variable integral equations by approximate product-integration. (auth)

46857 SINGULARITIES OF CONFORMAL-INVARIANT SCATTERING AMPLITUDES. Coon, Darryl D. (Univ. of Washington, Seattle). J. Math. Phys. (N.Y.), 10: 1314-18(Aug. 1969).

It is shown that conformal invariance alone, with no specific dynamics, provides severe constraints on the location of singularities of the off-mass-shell amplitude for elastic scattering of spinless particles. Kinematical and dynamical singularities are correlated in an interesting fashion with the singular and general solutions of differential equations which follow from the momentum-space requirements of conformal invariance. Explicit expressions are found for the location of singularities which are independent of t, the square of the momentum transfer. The possibility of having an asymptotic behavior of t^{α} for large t together with singularities specified by the function α is discussed. (auth)

46858 OPERATOR REDUCTION OF THREE-BODY SCATTERING EQUATIONS. Kazaks, Peteris Alexander. Davis, Calif., Univ. of California, 1968. 65p.

Thesis.

Operator multipliers of the Lippmann–Schwinger (L-S) equation are used to obtain calculable and unique solutions. The multiplier method is used as a basis for determining the relation between various formulations of the three-body problem. The properties of the multipliers determine whether the multiplied equation yields fewer, extra, or unchanged bound state solutions. It is pointed out that the noncompact kernel of the L-S equations for three-body problems both renders the solutions incalculable and produces nonunique solutions for the wave functions. The method proposed by Sugar and Blankenbecler to make the kernel compact is examined. It is found that the inverse of their arbitrary operator L must exist in order to not reduce the number of bound states. Using a specific operator L or M as a multiplier of the L-S equations formal but calculable solutions are obtained. The operator manifestly cancels the noncompact part of the L-S kernel and introduces neither fewer nor spurious bound state solutions since its inverse exists and is known. It is then found that the formal but calculable solutions of the three-body scattering formulations of Faddeev, Rosenberg, Lovelace, Newton and Noble are identical to each other and identical to the solution of the multiplied L-S equations. The multiplier method is used to obtain a criterion for the spurious bound states introduced by the Weinberg formulation of three-body scattering. This new criterion is an integral equation involving only the potentials of the problem. To indicate its usefulness and applicability, the multiplier method is used in discussing corrections to the distorted wave and shell model approximations. (Diss. Abstr.)

Particle Accelerators

Refer also to abstracts 45455, 45523, and 47037.

46859 (BNL-13945) SIMULTANEOUS INTERNAL AND EXTERNAL TARGETING AT THE AGS. Blumberg, L. N.; Barton, M. Q.; Fox, J. D.; Glenn, J. W.; Nawrocky, R. J.; Pallas, F. O.; Soukas, A. V.; van Steenbergen, A. (Brookhaven National Lab., Upton, N. Y.). [1969]. 11p. (CONF-690811–8). Dep. CFSTI.

From 7th International Conference on High Energy Accelerators, Moscow, USSR.

Simultaneous internal targeting and resonant extraction has been studied at the Brookhaven AGS. We show that the vertical emittance of the external beam increases approximately quadratically as a function of beam fraction internally targeted to ~1.8 of the non-simultaneous emittance for 50% interacting internally. The external beam extraction efficiency is approximately constant in the interval 0 to 80% internally targeted. However, internal targeting efficiency decreased by about 20% in the simultaneous mode due to decreased machine aperture within the $3\lambda/2$ slow external beam orbit deformation. This loss was reduced by installation of a $\lambda/2$ orbit deformation. It was concluded that the simultaneous targeting method is more effective than nonsimultaneous targeting in utilization of the AGS beam for the case where internal targeting is limited to $\leq 1.5 \times 10^{12}$ protons/pulse and the AGS beam exceeds $\sim 2 \times 10^{12}$ protons/pulse. (auth)

46860 (BNWL-1051(Pt.3), pp 28-30) TRITIUM TARGET SCANNING USING SURFACE-CONTOURED DIODES: PRELIMINARY RESULTS. Morton, T. H. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.).

Deuteron irradiation of tritium deposited on a titanium-coated, stainless steel target produces neutrons by a $^{3}H(d,n)^{3}He$ reaction. Repeated use of these targets requires a knowledge of the tritium distribution on the planchets to accurately determine the source geometry for close-in neutron irradiations. The irradiation geometry is critical since the source-to-subject distance is small. Fluctuations is the dose rate were noticed, suggesting the possibility of redistribution of the tritium on the target. Because of the small size of the surface-contoured diodes and the large amount of activity available (approximately 5 Ci of ^{3}H per target) these units seemed to be a likely choice for a scanning detector to explore the tritium distribution in targets. (auth)

46861 (CERN-69-15(Rev.)) TRANSVERSE OSCILLATIONS OF A RELATIVISTIC PARTICLE BEAM IN A LAMINATED VACUUM CHAMBER. Zotter, B. (European Organization for Nuclear Research, Geneva (Switzerland)). June 9, 1969. 56p. Dep. CFSTI (U. S. Sales Only).

Coherent transverse oscillations of relativistic particle beams may limit the number of particles that can be contained in accelerators and storage rings. In order to calculate the limit of stability one needs to know the electric and magnetic fields caused by the oscillating beam. These fields exert an electromagnetic force on the beam particles, which may be expressed by the dispersion relation coefficients U and V for the in-phase and out-of-phase components. While the in-phase component only shifts the betatron frequency — which may cause problems if resonances are crossed — the out-of-phase component will always give rise to instability in a monochromatic beam. The instability may be suppressed by a proper amount of energy and/or amplitude spread. The dispersion relation coefficients for vacuum chamber walls consisting of several layers of material are discussed. A method is described which allows the calculation of U and V for a cylindrical beam surrounded by an arbitrary number of concentric layers, each layer being characterized only by three material constants: permeability, permittivity, and conductivity. The dispersion relation coefficients are evaluated numerically, and analytic expressions are found in the long wavelength limit for not too complicated wall configurations. Simple walls consisting of ceramic, Ferrite, or metal are discussed, as well as metal walls of finite thickness and metallized ceramic walls. Also the influence of structures outside the vacuum chamber is investigated. The results are presented in the form of graphs of the dispersion relation coefficients for typical ISR parameters. Of special interest is the fact that a metal wall thinner than the skin depth will have a strong influence on U and V, even for the smallest thicknesses that can be produced in practice. In general, both U and V will be much larger than for a thick wall. Ceramic walls show a large increase of U and V at mode numbers for which the wavelength is in resonance with the thickness of the ceramic. Thin metallization layers on the inside of the ceramic wall tend to damp these resonances in addition to the suppression of electrostatic surface charges. (auth)

46862 (COO-535-598) ON-LINE PROMPT AND DELAYED ELECTRON AND GAMMA RAY SPECTROSCOPY AT THE UNIVERSITY OF COLORADO CYCLOTRON LABORATORY. Konijn, J.; Klank, B.; Jett, J. H.; Ristinen, R. A. (Colorado Univ., Boulder). Aug. 1969. Contract AT(11-1)-535. 22p. (CONF-690818–2). Dep. CFSTI.

From International Conference on Radioactivity in Nuclear Spectroscopy, Nashville, Tenn.

The experimental facility at the University of Colorado 132-cm FFAG cyclotron for on-line measurements of gamma-ray and conversion electron spectra is described. Lithium-drifted germanium detectors, a two-meter curved crystal diffraction spectrometer, and a broad-range electron transport solenoid lithium-drifted silicon spectrometer are used. Experimental data are presented for proton reactions in tantalum foils and for proton reactions on ^{159}Tb and ^{169}Tm. (W.H.K.)

46863 (IFVE-SKU-68-76) TUNING OF THE INJECTION CHANNEL OF THE IFVE 70-GeV PROTON SYNCHROTRON. Demikhovskii, D. A.; Lomov, K. P.; Myae, E. A.; Obchinnikov, M. F.; Troyanov, E. F. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Serpukhov. Institut Fiziki Vysokikh Energii). 1968. 25p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The results of the tuning of the 70 GeV proton synchrotron injection channel are reported. The characteristics of the magnetic optic elements and the beam observation system are given. The methods and the results of the channel tuning by means of the proton beam are discussed. (auth)

46864 (ITEF-651) CONDENSERS FOR BENDING BEAMS OF CHARGED PARTICLES. Gol'din, L. L.; Skachkov, S. V. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1969. 16p. (In Russian). Dep. CFSTI (U. S. Sales Only).

To bend beams of charged particles it is highly desirable to use condensers with an electric field which is uniform after averging along the trajectories of the particles. The field of such a condenser specially designed to be installed into vacuum chambers of ion-guides and accelerators has been experimentally studied. Condenser electrodes have been placed along the surface of a cylinder of oval cross-section and have been separated by a gap which seems to have a form of a broken line when viewed from above. It is shown that the averaged field is uniform with a precision of 4% at distances greater than the gap width from the electrodes. (auth)

46866 (LA-4219) NUMERIC SOLUTION OF THE FUNDAMENTAL MODE OF CYLINDRICALLY SYMMETRICAL RESONANT CAVITIES. Rich, Walter F.; MacRoberts, Martin D. J. (Los Alamos Scientific Lab., N. Mex.). July 15, 1969. Contract W-7405-eng-36. 10p. Dep. CFSTI.

The numeric solution of the fundamental mode of cylindrically symmetrical resonant cavities is achieved with a FORTRAN program by using a double iterative process on the eigenvalue and eigenfunction. The primary input consists of the boundary of the figure, and the output consists of the three components of the electric and magnetic field that exist in this type of problem. Other output is possible, but is dependent upon the normalization of the field components. (auth)

46866 (PPAR-14) PRECETRON: A PRINCIPLE FOR OBTAINING PION-PION AND MUON-MUON COLLISIONS. Macek, Robert; Maglic, Bogdan (Princeton-Pennsylvania Accelerator, Princeton, N. J.). June 24, 1969. Contract AT(30-1)-2171. 43p. Dep. CFSTI.

A storage device for $\pi + \pi$ collisions in the mass region of the meson (ρ), and for $\mu + \mu$ collisions was proposed and its parameters calculated. The orbit-precession device called the precetron, has a large momentum acceptance of pions and large angular acceptance in contrast to a conventional storage ring which would require well-defined momentum and small angular divergence in order to have the pions captured. Single particle orbits and pion densities are calculated, and the collision rate is discussed. After several pion lifetimes the muons from the decaying pions orbit in similar precessing orbits to those of the pions and similar collision rates can be obtained. (J.F.P.)

46867 (TID-25186) SPEAR DESIGN REPORT. STANFORD POSITRON-ELECTRON ASYMMETRIC RINGS. (Stanford Linear Accelerator Center, Calif.). Aug. 1969. Contract AT(04-3)-515. 54p. Dep. CFSTI.

The conceptual design for the Stanford Positron-Electron Asymmetric Rings is presented. Two beams circulate in independent rings and interact in two regions where they cross with a comparatively large horizontal angle. A cost estimate and schedule and a parameter summary are included. (W.H.K.)

46868 USE OF THE ELECTRON STORAGE RING FOR EXPERIMENTS ON THE ELECTRON EXCITATION OF NUCLEI. Zelevinskii, V. G.; Nikolenko, D. M.; Popov, S. G.; Tumaikin, G. M. (Inst. of Nuclear Physics, Novosibirsk, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 686-9(Apr. 1969). (In Russian).

Neutron scattering methods allow the direct determination of the elastic and inelastic form factors of the studied nucleus. The electrospallation of deuterons and other very light nuclei yields a direct indication about the internuclear forces and the structure of nucleons. Plans have been made to carry out scattering experiments of 80- and 40-MeV electrons by various nuclei at the Institute of Nuclear Physics, using one of the tracks of the VEP-1 colliding beam storage ring. By using an electron accelerator, the electron beam may be rendered practically continuous; the storage rings are also studied for operations with thin and very thin targets. As a result of radiative attenuation of the radial-phase oscillations, the energy scatter in the storage ring is small. The electron energy resolution of the system is <100 keV. The data treatment of the machine is similar to that used in the authors' previously described paired γ spectrometer, and may be computerized. (TTT)

46869 BEAM OPTICS AND PARTICLE TRANSPORT. Skarek, Paul. Fortschr. Phys., 17: 277-311(1969).

Methods and results of beam optics with respect to the transport of charged particle beams in experiments on high energy accelerators are reviewed. (auth)

46870 HIGH ENERGY ACCELERATORS AND PHYSICS OF ELEMENTARY PARTICLES. Citron, A. (Institut fuer Experimentelle Kernphysik, Karlsruhe, Ger.). Naturwissenschaften, 56: 153-7(Apr. 1969). (In German).

The principles of experimental techniques are briefly summarized. The development of the knowledge of nuclear forces is outlined. The construction and characteristics of accelerators and storage rings are discussed. New concepts in the dimensioning of accelerators are indicated. The evaluation of experimental results with high energy accelerators is considered. (J.S.R.)

46871 RECENT DEVELOPMENTS ON THE DYNAMITRON ACCELERATOR. Cleland, Marshall R. (Radiation Dynamics, Inc., Westbury, N. Y.). pp 230-61 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18-20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.

See CONF-680440.

A general description of the Dynamitron accelerator is given; the high current rating of the Dynamitron generator is discussed; and the development of tandem Dynamitrons is described. (W.H.K.)

46872 HEAVY ION ACCELERATION. Rose, Peter H.; Starks, William E. (High Voltage Engineering Corp., Burlington, Mass.). pp 262-92 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18-20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.

See CONF-680440.

Particular aspects of heavy ion acceleration in the tandem Van de Graaff accelerator are discussed. Ion sources, charge changing collisions, electron loss, electron capture, equilibrium charge distribution, scattering, energy loss and straggling, vacuum requirements, beam bunching, and computer control are considered. (51 references) (W.H.K.)

46873 EFFECT OF R. F. ASYMMETRIC OSCILLATIONS IN STORAGE RING CAVITY ON BEAM TRANSVERSE MOTION STABILITY. Orlov, A. K.; Ryabtsov, A. V. At. Energ. (USSR), 27: 23-6(July 1969). (In Russian).

The process of excitation of rf asymmetric oscillations in a storage ring cavity with the circulating beam is studied. The effect of the oscillations on particle transverse motion stability is examined. As a result of the self-consistent problem investigation it is proved, that the excitation process is characterized by the increments depending on the beam longitudinal current constant. The dependence is nonlinear in general, but for a weak current it becomes linear. On the basis of the results obtained it is possible to explain why the particle transverse damping motion remains practically constant, when the current increases above 500 ma. This phenomenon, which was observed in the storage ring VEPP-2 at the Institute of Nuclear Physics of the Siberian Division of the USSR Academy of Sciences, cannot be understood from the published theory of interaction between coherent betatron oscillations and external systems, developed for a given motion approximation by the other authors. (auth)

46874 HIGH-INTENSITY 700 MeV PHASOTRON OF JINR. Glazov, A. A.; Denisov, Yu. N.; Dzhelepov, V. P.; (and others). At. Energ. (USSR), 27: 16-22(July 1969). (In Russian).

The possibility of the essential increasing of the phasotron intensity by using a space varying magnetic field increasing with the radius is investigated. A method of choice of the main parameters of such an accelerator is described. Numerical calculations are given for the synthrocyclotron of the Laboratory of Nuclear Problems of the Joint Institute for Nuclear Research in Dubna. By this modification the intensity of the accelerator will be increased up to 50 microamperes. (auth)

46875 UNIVERSAL SCATTERING CHAMBER FOR EXPERIMENTAL NUCLEAR PHYSICS. Mende, A.; Otto, G.; Schmidt, K.-D. (Karl-Marx-Univ., Leipzig). Kernenergie, 12: 209-16 (June 1969). (In German).

A scattering chamber is described which is designed for nuclear reaction angular distribution and correlation experiments. The design of the chamber and the method of its adjusting are explained. Special measuring windows are arranged within the wall of the chamber for using a gamma-ray detector outside the chamber. Gamma-ray absorption of the chamber has been measured both inside and outside the window region in horizontal and vertical directions. A ^{60}Co preparation and the ^{19}F(p,$\alpha\gamma$) reaction have been used as the gamma-ray sources. Consequently, the absorption curve has been obtained for two different gamma energies. (auth)

46876 HIGH-FREQUENCY ION SOURCE. Akatsu, Kaoru (to Hitachi Ltd.). Japanese Patent 1969-15834. July 8, 1969. Filed Jan. 25, 1965.

The high-frequency ion source is used in connection with high-voltage producing machines such as the Van de Graaff and the

Cockcroft–Walton's generators. As usual, it includes an anode and an ion outlet constituting a discharge tube and members outside the tube for supplying high-frequency power. By the method proposed, shielding of the high-frequency power due to deposits produced by sputtering can be eliminated, and the life of the discharge tube is lengthened. Construction is simple, and efficiency is improved. The high-frequency ion source consists of the following: a cylindrical tube; a flange plate with a central hole for ejecting the ion at one end of the tube; an anode plate closing the other end of the tube; lead wires connected to the anode and to the flange from a high-frequency power source; a condenser in the lead wire to the anode, and a lead wire connected to the anode from the anode power source. In this way, the anode and the flange with the central hole are used to supply high-frequency power in common. (NSA of Japan)

46877 PARTICLE ACCELERATOR. Suematsu, Shigeru (to Hitachi Ltd.). Japanese Patent 1969-15840. July 8, 1969. Filed Mar. 22, 1965.

The design of a Cockcroft–Walton accelerator is presented. The power source for the particle source at the top of the machine is provided with a generator, which is also located at the top level. An insulated belt to operate the generator, is driven by means of a motor at the ground level. The belt, motor, etc., are contained in an insulating cylinder. The belt is prevented from absorbing atmospheric moisture, to avoid electric breakdown. Furthermore, the insulating cylinder can serve as the support of a high-voltage electrode of the machine. The particle accelerator consists of the following: series of condensers and rectifiers; a high voltage electrode at the top; an accelerating tube including the accelerating electrodes, etc.; a particle source; a generator; a motor; a belt running between the generator and the motor; and a vertical insulating cylinder, which encloses the belt and the motor. (NSA of Japan)

46878 ACCELERATING TUBE FOR THE BETATRON. Sasaki, Masahiro (to Shimadzu Seisakusho Ltd.). Japanese Patent 1969-13920. June 20, 1969. Filed Dec. 31, 1965.

The method proposed for holding a circular accelerating tube in the betatron has the following advantages: easy and accurate holding of the accelerating tube; elimination of movement of the tube over the years; reduction in size of the central magnetic poles; and simple construction. Because of the firm holding of the accelerating tube, the output of the betatron can be highly stabilized. A round disc with a central hole for the pole pieces to enter is fixed in the inner circumference of the circular accelerating tube, or, the disc may be embodied with the accelerating tube; the disc can be made of a plastic. To fix firmly the circular accelerating tube in the betatron, the upper and lower magnetic poles hold the disc itself tightly, with shock-absorbing material between the poles and the disc. (NSA of Japan)

46879 DEVICE FOR PRODUCING PULSED BEAM IN A PARTICLE ACCELERATOR. Suganomata, Shinji (to Hitachi Ltd.). Japanese Patent 1969-13360. June 14, 1969. Filed June 21, 1965.

A method is proposed for producing a pulsed beam in a particle accelerator, where the interval between the pulses, and the pulse width can be adjusted independently. Parallel deflecting plates, an oscillator, and a shielding plate with a central slit are used; and an alternating current is applied to the deflecting plates. The beam, passing between the deflecting plates, emerges through the slit as pulsed beam. The device includes a means to cut the sinusoidal wave from the oscillator into trapezoidal waves of a specific crest value, and a means to adjust crests of the trapezoidal waves to the same value and supply the waves to the deflecting plates. The pulsed beam of charged particles thus obtained is suitable for nuclear physics, reactor physics, and other irradiation purposes. (NSA of Japan)

46880 METHOD OF ACCELERATING PARTICLES IN A BETATRON. Kamei, Hisashi (to Tokyo Shibaura Electric Co.). Japanese Patent 1969-13358. June 14, 1969. Filed Apr. 15, 1965.

By the method proposed, the efficiency of extracting accelerated charged-particles in a betatron is increased considerably. It includes the circular accelerating tube through which charged particles are accelerated in an orbit, the yokes with central magnetic poles and other magnet, a means to take out the beam of accelerated particles, a particle source, etc. Electromagnetic coils are wound around the circular accelerating tube. When extracting the beam of accelerated charged particles from the circular tube, the condition of particle acceleration in the accelerating tube is disturbed locally by means of the electromagnetic coils. Then, the beam is taken out in the usual manner. (NSA of Japan)

46881 PARTICLE ACCELERATOR. Arakawa, Razuo (to Matsushita Electric Industrial Co.). Japanese Patent 1969-13356. June 14, 1969. Filed May 20, 1965.

The particle accelerator proposed employs a Cockcroft–Walton's machine. It includes a series of condensers and rectifiers, an accelerating tube with electrodes, a scanning means, a target, etc. Electric discharges between the accelerating electrodes, often extending over the accelerating-tube length, are eliminated, and stabilized operation is achieved. The accelerating electrodes and the stages of voltage generation in the Cockcroft–Walton's machine are connected in two ways. In one method, the voltage-generating stages are connected to the accelerating electrode through resistances; and in the other, the stages are connected to the electrode through voltage-dividing resistances. The connections of these two types are arranged alternately throughout the length of the accelerating tube. In this manner, discharges between the accelerating electrodes are entirely removed. (NSA of Japan)

46882 CALCULATION OF THE RESIDUAL PHOTON DOSE RATE AROUND HIGH-ENERGY PROTON ACCELERATORS. Armstrong, T. W.; Alsmiller, R. G. Jr. (Oak Ridge National Lab., Tenn.). Nucl. Sci. Eng., 38: 53-62(Oct. 1969).

Calculations were carried out to determine the time dependence of the residual photon dose rate around a high-energy proton accelerator. The development of the nucleon-meson cascade, the residual nuclei production, and the photon transport are calculated using Monte Carlo methods. Proton beams of 3- and 200-GeV and shields in the form of infinite cylinders of iron and heavy concrete are considered. Although the 3-GeV calculations are carried out with some exactitude, the results for the 200-GeV case must be considered very approximate since the energy and angular distributions of the products from nuclear interactions in this energy range are not well known. (auth)

46883 DETERMINATION OF CURRENT AND ITS DISTRIBUTION IN A PROTON BUNCH. Dimov, G. I.; Dudnikov, V. G. Prib. Tekh. Eksp., No. 3, 18-20(May-June 1969). (In Russian).

A method was described for measurement of parameters of a fast particle bunch (intensity, position, current density distribution) without interfering with the particle bunch. The relation between the density of a beam of electrons, from the ionization of residual gas, and the current density of individual particle bunches was used. (tr-auth)

46884 INVESTIGATION OF A CORONA TRIODE FOR ELECTROSTATIC ACCELERATORS. Berets, D.; Kostka, P. (Central Inst. of Physics Research, Budapest). Prib. Tekh. Eksp., No. 3, 24-7(May-June 1969). (In Russian).

In the design of stabilization systems for the high voltage of electrostatic accelerators investigations were conducted on a corona triode based upon the different pressures of insulating gases. It was established that the current of the corona triode is proportional to the square of the voltage in electrostatic accelerators. (tr-auth)

46885 DIGITAL SYSTEM FOR MAINTAINING THE MAXIMUM BEAM INTENSITY OF NEUTRON GENERATORS. Kolesnikova, L. P.; Mazanova, A. M.; Nekhai, A. P.; Slyusar, V. N. (Physical-Technical Inst., Leningrad). Prib. Tekh. Eksp., No. 3, 94-8(May-June 1969). (In Russian).

A digital system is described for maintaining the maximum beam intensity of a 200-keV neutron generator. The accuracy of the system is approximately 5%. (tr-auth)

46886 STABILIZING THE AMPLITUDE OF RADIAL BETATRON OSCILLATIONS ON PASSAGE THROUGH THE RESONANCE $Q_r = 2/3$ IN A CYCLOTRON. Kulikov, O. F.; Metal'nikov, Yu. N.; Shorin, K. N. At. Energ. (USSR), 27: 163-4(Aug. 1969). (In Russian).

In accelerators with weak focusing, a wavering in the radial betatron oscillations at the resonance $Q_r = 2/3$ can cause a series of undesirable events such as a change in the form of the cross-section and a loss of beam intensity. The primary reason for an increase in amplitude oscillation at this resonance is the presence of secondary harmonics, especially the second harmonic, in the control magnetic field. The wavering can be reduced almost to zero by artificially introducing a second harmonic of the proper amplitude and phase by use of a field correction coil on the 680 MeV synchrotron racetrack. The radial distribution of the field created by the coil was close to the required parabolic distribution. The intensity loss was reduced from ~27% under normal operating conditions to less than 0.4% on introduction of current pulses synchronized with the moment of passage through the

resonance $Q_r = 3/2$. This behavior indicates an almost complete compensation of the second harmonic in the magnetic field of the accelerator. This is an efficient and simple method of stabilizing the amplitude of the oscillations at the resonance $Q_r = 3/2$. (TTT)

46887 CHARGE-TRANSFER ACCELERATOR FOR NUCLEAR STUDIES WITH POLARIZED BEAMS OF ACCELERATED IONS. Val'ter, A. K.; Belyaev, V. Kh.; Levchenko, Yu. Z.; Pivovar, L. I.; Kiselev, I. E.; Slabospitskii, R. P.; Deineko, A. S.; Taranov, A. Ya.; Tsytko, S. P. At. Energ. (USSR), 27: 160-1(Aug. 1969). (In Russian).

A beam of negative polarized ions are focused by lens on a charge-transfer target foil less than 0.1 microns thick and is then accelerated to hit the target. The number of ions passing through the charge-transfer accelerator is 70% with a current of 4 microamps (for unpolarized beams) and a beam diameter of 4 mm. The intensity of a polarized deuteron beam at the accelerator inlet was 1×10^{-9} amps. The polarized deuteron current passing through the diaphragm was stable at a level of 2×10^{-10} amps, which corresponds to a 20% beam transmission. A magnet is available for the production of deflected beams. The error in determining the energy of the accelerated ions by means of nuclear magnetic resonance was ±0.1%. Studies show that the polarization of the accelerated beam is well stabilized so that it is possible to carry out investigations of nuclear interactions which depend on spin states. (TTT)

46888 PRECISION VACUUM FURNACE FOR NEUTRON INTENSITY MEASUREMENTS. Antonini, M.; Nicotera, E. (CNEN, Ispra, Italy). J. Phys., E (London), 2: 890-1(Oct. 1969).

A high stability vacuum furnace for neutron spectroscopy is described. This furnace was used in measurements of small-angle scattering of neutrons at about 800°C. The measured stability at this temperature was of the order of 0.05°C. (auth)(UK)

46889 AMERICAN 200 GeV ACCELERATOR. Livingston, M. S. (National Accelerator Lab., Batavia, Ill.). Nature (London), 223: 1005-8(Sept. 6, 1969).

The 200 GeV accelerator at Batavia is due to begin operations in 1972. It differs from earlier designs in having a booster synchrotron, and as a consequence the main ring magnets are considerably smaller. A description is given of the principle of operation, design features, main ring and booster magnets, radiofrequency acceleration, vacuum system, enclosures and shielding, and experimental facilities. (UK)

46890 DETERMINATION OF THE PARTIAL THICKNESSES OF MULTICOMPONENT TARGETS. Malakhov, I. Ya.; Deineko, A. S.; Andreev, G. B. (Inst. of Technical Physics, Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 676-8(Apr. 1969). (In Russian).

Study of nuclear reaction often requires the use of multicomponent films with unknown chemical and isotopic composition. Thickness measurements are not sufficient to identify these targets because the concentration relations are often not known. They may be derived by determining the partial spectrum resulting from elastic scattering or charged-particle (e.g., proton) reactions with the target components. The relative partial yields of the elastic scattering or reaction, corresponding to areas of peaks in the spectrum are proportional to the partial thicknesses, yielding the required n equations for n components. In order to retain the data needed for the computation, the concentration of the components is varied, using a supplementary target. Errors of measurement by this method of a two component system amount to about 5%, of a three component system about 10% and four component ones about 15%, if the overall thickness of the target is of the order of 10^{18} atoms $\cdot$ cm^{-2}. (TTT)

PHYSICS (NUCLEAR)

Neutron Interactions with Matter

Refer also to abstracts 46566, 46943, 46964, 47037, and 47277.

46891 (AAEC/TM–505) SLABBO: A DISCRETE ORDINATE NEUTRON TRANSPORT CODE IN PLANE GEOMETRY WITH ANISOTROPIC SCATTERING. Clancy, B. E. (Australian Atomic Energy Commission Research Establishment, Lucas Heights). July 1969. 8p. Dep. CFSTI (U. S. Sales Only).

A description is given of the SLABBO code which computes solutions of the inhomogeneous multigroup neutron transport equation of plane slabs with free boundary conditions. The neutron source at one boundary can be chosen arbitrarily in both energy and angle and the code converges on the angular fluxes transmitted through the slab. Anisotropic scattering is permitted and an adjoint option is included. (auth) (Australia)

46892 (AD–685704) EXTENDING THE NEAREX STATISTICAL MODEL NUCLEAR CROSS-SECTION CODE TO SIMULTANEOUS (n,p) (n,γ) REACTIONS. Green, J. M.; Hubbard, H. W.; Bloom, S. D. (RAND Corp., Santa Monica, Calif.). Mar. 1969. Contract F33657-69-C-0107. 28p. (RM–5899). CFSTI.

A description, with source deck listing and flow charts, of four improvements made to the Argonne National Laboratories' ABACUS-NEAREX program for computing nuclear cross-sections for neutron scattering problems is given. NEAREX uses the Hauser–Feschbach calculation scheme and the optical potential model. A problem that caused machine overflow when protons of very low kinetic energy were involved was solved by setting the transmission coefficient to zero, thus avoiding the wave function calculation. (This is a reasonable approximation when the Gamow penetration factor is extremely small.) The original code set the neutron mass equal to 1; the exact value is now used, with necessary changes in the reduced mass correction. Other changes involve resetting certain variables to zero before each of successive computer runs, and properly restoring the optical well parameters when the original code fails to make such a restitution in part of the gamma computation. (auth) (USGRDR)

46893 (AD–686075) ANTE: A FORTRAN COMPUTER CODE FOR THE SOLUTION OF THE ADJOINT NEUTRON TRANSPORT EQUATION BY THE MONTE CARLO TECHNIQUE. Cohen, M. O. (Mathematical Applications Group, Inc., White Plains, N. Y.). Feb. 1969. Contract DASA01-68-C-0115. 100p. (MAGI–1475; DASA–2263). CFSTI.

The theory of the "adjoint Monte Carlo" game has been implemented, including particularly, the derivation and treatment of neutron "adjoint" cross section data. These techniques have been incorporated into the ANTE code, reported herein. The powerful geometric capabilities of the Combinatorial Geometry system also have been incorporated into ANTE. (auth) (USGRDR)

46894 (GA–9489) INTEGRAL NEUTRON THERMALIZATION. Quarterly Progress Report for the Period April 1, 1969–June 30, 1969. Slaggie, E. L.; Borgonovi, G. M.; Houston, D. H. (Gulf General Atomic, Inc., San Diego, Calif.). July 15, 1969. Contract AT(04-3)-167. 33p. Dep. CFSTI.

Calculations of the coherent scattering law and the total cross section for polycrystalline beryllium are presented. Studies on phonon frequency shifts in zirconium hydride and graphite due to thermal expansion are described. Crystal binding effects on Doppler broadening of neutron absorption resonances are discussed and calculations for ^{238}U in UO_2 are presented. (J.W.R.)

46895 HIGH-RESOLUTION STUDIES OF THE CRITICAL SCATTERING OF NEUTRONS FROM IRON. Collins, M. F.; Minkiewicz, V. J.; Nathans, R.; Passell, L.; Shirane, G. (Brookhaven National Lab., Upton, N. Y.). J. Phys. Soc. Jap., 26: Suppl., 169-73(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

The dynamics of spins in iron near T_c were studied through high-resolution measurements of neutron critical scattering. The hydrodynamic region, the transition region, and the spin wave region were covered. (J.W.R.)

46896 INELASTIC CRITICAL NEUTRON SCATTERING FROM TERBIUM. Als-Nielsen, J.; Dietrich, O. W. (Danish Atomic Energy Commission Research Establishment, Roskilde, Denmark). J. Phys. Soc. Jap., 26: Suppl., 183(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

Data on neutron critical scattering in terbium were used to determine parameters characterizing the critical fluctuations of spin ordering in space and time near T_N. (J.W.R.)

46897 QUANTUM CORRECTIONS TO THE NEUTRON TRANSPORT EQUATION. Diana, E.; Scotti, A. (EURATOM, Ispra, Italy). J. Phys. Soc. Jap., 26: Suppl., 248-50(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

Quantum corrections to the neutron transport equation which are of importance in the low energy limit are derived. The method of projection operators is used. (J.W.R.)

46898 INTERMEDIATE NEUTRON RESONANCE ABSORPTION WITH INTERFERENCE SCATTERING IN HETEROGENEOUS SYSTEMS. Ishiguro, Yukio; Takano, Hideki (Japan Atomic Energy Research Inst., Tokai). J. Nucl. Sci. Technol. (Tokyo), 6: 380-9(July 1969).

A new method for intermediate treatment of resonance absorption developed for homogeneous systems is applied to heterogeneous systems. In the present method, the interference between potential and resonance scattering is taken into account. Also taken into account is the temperature dependence of the parameters used in the intermediate treatment. By making use of the Wigner type of simple rational approximation for the collision probability, heterogeneous systems are treated by means of the intermediate-resonance absorption, and an analytic expression is given for calculating the resonance integral. Discussions are given on the assumption of the spatially flat flux, from the intermediate resonance approach. Calculations of the resonance integral were performed for typical resonances of ^{238}U in square lattices of UO_2 fuel rods and moderator. The results for the resonance integral obtained with the IR approximation are compared with the exact results. Comparisons are also made for the Doppler coefficient of the resonance integral. The results obtained with the present method will be shown to be in fairly good agreement with those obtained from exact numerical approach. (auth)

46899 THE ROLE OF THE ADJOINT IN NEUTRON FLUCTUATION ANALYSIS WITH SPECIAL EMPHASIS ON THE DETECTOR EFFICIENCY. Congdon, Myron Edward. Seattle, Univ. of Washington, 1968. 131p.

Thesis.

The fundamental equations for fluctuations about the mean neutron density are studied for a reactor-detector system in which the detector is treated as an integral part of the system. The reactor-detector system is described, mathematically, as a general Markov process, and expressions for various descriptive parameters are derived in a consistent manner, within the context of the basic equations. The role of the general adjoint neutron density is discussed, with special emphasis on the mean and second-moment functions. A relationship between the second-moment equations similar to the relationship between first-moments (mean and its adjoint) is observed. The extension to higher moments is also noted. A reduction of the second-moment equations is carried out, without approximation, using a variational principle. This consistent reduction allows a definition of the parameters involved, especially a definition of the detector efficiency, through a comparison of this reduced form with the usual point-reactor equations. The parameters defined contain weighting functions dependent upon the number of detectors used in the experiment. Comparison of the point-reactor and adjoint-weighted definitions for detector efficiency, in several calculational models, reveals large discrepancies. The adjoint-weighted efficiency is more than an order of magnitude larger than the point-reactor result for reactor sizes in the typical power reactor class. Preliminary comparison with experiment demonstrates the superiority of the adjoint-weighted definition. A simple calculational model, suitable for hand calculations, is presented for the detector efficiency. This perturbation theory model is surprisingly good, since the two large, inherent errors tend to cancel. A method for calculating the efficiency for two-detector experiments is found, and one- and two-group-diffusion theory sample calculations are presented. Two competing effects, the domination of the fundamental mode and the relative increase in correlation as the two detectors move closer together, combine to provide a system dependent variation in the spatial behavior of the efficiency. The absolute magnitude of the two-detector efficiency is provided by normalization to the one-detector or auto-correlation result. The variational principle reduction technique is applied to the cross-power spectral density equations and an expression for the coherence function is found by comparing the adjoint-weighted

result with the usual point-reactor expressions. This comparison illuminates the role and functional dependence of the parameters involved. (Diss. Abstr.)

46900 ON SPIN DEPENDENCE OF THE INTERACTION OF SLOW NEUTRONS WITH NUCLEI OF DEUTERIUM, NITROGEN, AND LANTHANUM. Ivanenko, A. I.; Lushchikov, V. I.; Taran, Yu. V.; Shapiro, F. L. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 47-50(July 1969). (In Russian).

The transmission in targets containing polarized deuterium, nitrogen and lanthanum was measured for polarized neutrons in the energy region 0.01 to 40 eV. The analysis of the experimental data confirms the conclusion of a previous experiment that the quartet nd scattering length is larger than the doublet one. Also some conclusions on the spin dependence of the neutron absorption by nitrogen and lanthanum are drawn. (auth)

46901 TOTAL MACROSCOPIC SLOW NEUTRON CROSS-SECTION FOR LIMITED INSULATION. Kuznetsov, V. A.; Zakharkin, I. I.; Bogomolov, V. N. At. Energ. (USSR), 26: 546 (June 1969). (In Russian).

Getinaks is a hydrogen-containing substance obtained by hot pressing paper and aldehyde resins. Its high neutron scattering cross section, high mechanical strength and easy workability make it a suitable material for the preparation of rotors in mechanical neutron selectors by time of flight. The total cross section of this material with a density of 1.36 g/cm^3 was determined as a function of neutron energy over the range of 10^{-2} to 10 eV. The neutron source was a critical assembly operating at a power of 40 watts. The experimental results show that the total macroscopic cross section of this material as a function of neutron energy has a form characteristic of other hydrogen-containing substances. (TTT)

46902 CALCULATIONS OF COLLISION PROBABILITIES. Carlvik, Ingvar (Aktiebolaget Atomenergi, Stockholm). Newslett. ENEA Comput. Programme Libr., No. 9, 5-17(June 1969).

The most common formulation of integral neutron transport theory is in terms of collision probabilities. The success of the collision probability method depends on the availability of fast and accurate methods for the calculation of collision probabilities. A brief account is given of methods that have been developed for various geometrical configurations, first the one-dimensional geometries, plane, annular, and spherical, and then the two-dimensional geometries, xy- and rz-geometry. Some special methods for self collision probabilities are also discussed. Some material on the particular mathematical functions that appear in formulas for collision probabilities is also presented. (auth)

46903 NUMERICAL STUDY FOR THE SOLUTION OF THE SPACE–TIME NEUTRON-DIFFUSION EQUATIONS. Brusa, L.; Giorcelli, M. (CISE, Milan). Newslett. ENEA Comput. Programme Libr., No. 9, 19-53(June 1969).

The analysis of the dynamic behavior of nuclear reactors often requires the solution of the space time multigroup neutron diffusion equations which form a system of partial differential equations of parabolic type. Using the method of "lines," the problem is reduced to finding the solution of an ordinary matrix differential equation. Some numerical methods commonly used are tested and the results compared. These approaches require, at each time step, the solution of a large system of linear equations. To this end, iterative methods are used and, to have acceptable running times, the choice of a convenient scheme is an important question. A nonlinear iterative procedure described by Wachspress is considered. This method is based on a variational acceleration procedure which is periodically applied to an otherwise conventional linear iteration. Illustrative results and numerical comparisons with some widely used iterative methods are given. (auth)

46904 SCATTERING MODEL FOR METAL HYDRIDES. Mehner, Juergen (Univ., Karlsruhe, Ger.). Atomkernenergie, 14: 295-6(July-Aug. 1969).

The cross section for the scattering of slow neutrons in metal hydrides is derived from a scattering model which takes into account the finite half width of the optical branch. The scattering kernel derived satisfies the detailed balance condition. In the limiting case of disappearing half width the results approach those of the Einstein model. (J.W.R.)

46905 INTEGRAL REFLECTION AND THE REFLECTING CAPABILITY OF A CRYSTAL MONOCHROMATOR. Men'shikov, A. Z.; Novak, L. I.; Dorofeev, Yu. A.; Arkhipov, V. G.; Sidorov, S. K. (Inst. of Physics of Metals, Sverdlovsk, USSR). Prib. Tekh. Eksp., No. 3, 28-32(May-June 1969). (In Russian).

The integral reflection and the reflecting capability of a crystal was calculated based on the structure and thickness of the crystal and the divergence of neutron beams. Experimental verification of the calculations was obtained. A diagram was constructed for obtaining the maximum integral reflection from Fe and Pb crystals. (tr-auth)

46906 NEUTRON WAVE PROPAGATION THROUGH GRAPHITE. Bansal, N. K. (Indian Inst of Tech., Delhi); Ghatak, A. K.; Ahmed, F. J. Nucl. Energy, 23: 439-41(Aug. 1969).

The neutron wave technique involves the sinusoidal modulation of a beam of thermal neutrons which impinges on the boundary of the system under investigation. Equations are given for the energy dependent flux corresponding to the fundamental spacial mode. The effect of chemical binding and large Bragg peaks in the transport section on the fundamental eigenvalues of the equations is studied using multigroup theory and various models for the scattering kernels and diffusion coefficient. (UK)

46907 SOME REMARKS ON THE CONCEPT OF GROUP CONSTANTS IN RESONANCE ENERGY REGION. I. RESONANCE SHIELDING FACTORS INCLUDING INTERFERENCE EFFECTS. Nakagawa, Masayuki; Takano, Hideki; Ishiguro, Yukio; Katsuragi, Satoru (Japan Atomic Energy Research Inst., Ibaraki). J. Nucl. Sci. Technol. (Tokyo), 6: 408-9(July 1969).

In order to examine the influence of self-overlapping and mutual shielding effects on resonance shielding factors, shielding factors were calculated by solving the neutron slowing down equations in homogeneous systems of ^{238}U, ^{239}Pu, and Fe, Na, and O moderators. Mutual shielding effects were found to contribute considerably to the shielding factors. The shielding factors were found to vary linearly with the ^{238}N/^{239}N ratio. (J.W.R.)

Nuclear Properties and Reactions, A≤ 5

Refer also to abstracts 46785 and 46900.

46908 (COO-7-515) POLARIZATION IN NUCLEON–DEUTERON SCATTERING. Haeberli, W. (Wisconsin Univ., Madison). Aug. 15, 1969. Contract AT(11-1)-Gen-7). 44p. (CONF-690710-1). Dep. CFSTI.

From International Conference on the Three-Body Problem, Birmingham, England.

A summary of the experimental information on polarization effects in nuclear-deuteron scattering is presented. The emphasis is on elastic scattering experiments but some mention is also made of polarization effects in the breakup channels. (J.W.R.)

46909 SCATTERING ASYMMETRY AND POLARIZATION OF THE PHOTODISINTEGRATION PRODUCTS OF ^{4}He. Arkatov, Yu. M.; Vatset, P. I.; Voloshchuk, V. I.; Marchenko, V. L.; Khodyachikh, A. F.; Chmil, V. I. (Physico-Technical Inst., Kiev). JEPT Lett. (USSR) (Engl. Transl.), 9: 384-7(June 5, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pisma Redaktsiyu, 9: 626-9(June 5, 1969).

The right-left asymmetry of the scattering in ^{4}He of protons and tritons from the ^{4}He(γ,p) reaction and ^{3}He from the ^{4}He(γ,n) reaction were measured. The data make it possible to estimate the contributions of small electric and magnetic multipoles in the gamma absorption. (J.W.R.)

46910 FINE STRUCTURE OF GIANT RESONANCE OF THE REACTION ^{4}He(γ,p)^{3}H. Arkatov, Yu. M.; Vatset, P.; Voloshchuk, V. I.; Kirichenko, V. V.; Prokhorets, I. M.; Khodyachikh, A. F. (Physical-Technical Inst., Kharkov). JETP Lett. (USSR) (Engl. Transl.), 9: 350-1(May 20, 1969).

Translated from Zh. Eksp. Teor. Fiz., Pis'ma Redaktsiyu, 9: 574-7(May 20, 1969).

The energy dependence of the cross section for the ^{4}He(γ,p) reaction was measured at 23 to 32 MeV with good resolution and statistics. (J.W.R.)

46911 SPIN EFFECTS IN THE ELASTIC p–^{4}He SCATTERING. Wilk, G. (Warsaw Univ.). Bull. Acad. Pol. Sci., Ser. Sci. Math. Astron. Phys., 17: 299-303(1969).

The differential cross section for elastic p–^{4}He scattering was calculated using the Glauber approximation and including spin effects. The results are compared with other data. (J.W.R.)

46912 APPLICATION OF KINEMATIC SINGULARITIES TO α PARTICLE SCATTERING ON HYDROGEN. Gonchar, V. Yu.; Zheltonog, K. S. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat. No. 4, 28-36(July-Aug. 1968). (In Russian).

It is shown that in measuring angular distributions of products of nuclear reactions the recoil of the target nucleus may influence the spectra. This is especially true when heavy ions are the bombarding particle. As an example, alpha scattering on hydrogen is analyzed. (J.W.R.)

Nuclear Properties and Reactions, $6 \leq A \leq 19$

Refer also to abstracts 45541, 46652, 46941, 46942, 46952, 47036, 47063, and 47084.

46913 (LA–4177) CROSS-SECTION MEASUREMENTS FOR THE $^{9}Be + d$ AND $^{12}C + t$ INTERACTIONS. Armstrong, D. D.; Beery, J. G.; Keaton, P. W. Jr.; Veeser, L. R. (Los Alamos Scientific Lab., N. Mex.). May 12, 1969. Contract W-7405-eng-36. 25p. Dep. CFSTI.

Cross sections were measured for the $^{9}Be(d,p)^{10}Be$, $^{9}Be(d,d)^{9}Be$, and $^{9}Be(d,t)^{8}Be$ reactions at 15.0 MeV; for the $^{12}C(t,p)^{14}C$, $^{12}C(t,d)^{13}C$, $^{12}C(t,t)^{12}C$, and $^{12}C(t,\alpha)^{11}B$ reactions at 16.0 and 20.0 MeV; and for $^{12}C(t,t)^{12}C$ scattering at 14.0 MeV. (auth)

46914 MEASUREMENT OF THE $^{12}C(p,2p)$ REACTION AT 385 MeV WITH GOOD MOMENTUM RESOLUTION. James, A. N.; Andrews, P. T.; Butler, P.; Cohen, N.; Lowe, B. G. (Liverpool Univ.). Nucl. Phys., A133: 89-100(1969).

A method of measuring absolute values of (p,2p) reaction cross sections at 385 MeV has been developed which uses wide range magnetic spectrometers. The measurements made on $^{12}C(p,2p)$ provide new evidence supporting the interpretation of the cross section in terms of a spectator model. This interpretation gives an estimate of the momentum distribution of the protons bound in ^{12}C and the results show that the effect of distortion of the ingoing and outgoing proton waves is to reduce the magnitude measured for the momentum distribution but not to change its shape. We find the magnitude of the peak of the p state distorted momentum distribution to be 0.27 ± 0.03 fm^3, a result not in agreement with previous measurements. The resolution in momentum space is sufficient to resolve the minimum of the p state distorted momentum distribution and we find that there is no conflict with the theoretical predictions of the depth of this minimum. (auth)

46915 POSSIBLE EVIDENCE FOR A QUADRUPOLE GIANT RESONANCE IN ^{16}O. Stewart, R. J. J.; Morrison, J. C.; Frederick, D. E. (Ames Lab., Iowa). Phys. Rev. Lett., 23: 323-6 (Aug. 11, 1969).

Angular distributions for the reaction $^{16}O(\gamma,p)^{15}N$ are presented from 21 to 32.5 MeV. The asymmetry coefficients A_1 and A_3 increase to a maximum at 30 MeV and indicate a broad quadrupole state centered near 27 MeV. (auth)

46916 DWBA ANALYSIS OF THE PROTON TRANSFER $^{12}C(^{11}B,^{12}C)^{11}B$ AT 28 MeV. Von Oertzen, W. (Institut de Physique Nucleaire, Orsay, France. Max-Planck-Institut fuer Kernphysik, Heidelberg); Gutbrod, H. H.; Voos, Ursula C.; Bock, R. Nucl. Phys., A133: 101-7(1969).

The DWBA analysis of the proton transfer in $^{12}C(^{11}B,^{12}C)^{11}B$ at an energy well above the Coulomb barrier, based on the theory of Buttle and Goldfarb, gives relative spectroscopic factors for ^{12}C, which agree with those derived from theory and other experiments. The absolute cross section disagrees with experiment by an order of magnitude. (auth)

46917 OPTICAL MODEL FOR LOW-ENERGY HELIONS SCATTERED FROM ^{16}O NUCLEI. Nurzynski, J. (Australian National Univ., Canberra). Nucl. Phys., A133: 23-32(1969).

Averaged angular distribution of elastically scattered ^{3}He particles from ^{16}O nuclei obtained from measurements carried out at six incident energies between 9.802 and 10.720 MeV has been analyzed using six or four parameters in the optical-model potentials with volume or surface absorption. The existence of discrete radius ambiguities for the real part of six-parameter potentials is demonstrated. Four-parameter potentials were found to be less ambiguous and produced as good fits as those obtained with the more complex six-parameter potentials. (auth)

46918 RADIATIVE CAPTURE OF HEAVY IONS. Feldman, W.; Heikkinen, Dale W. (Stanford Univ., Calif.). Nucl. Phys., A133: 177-212(1969).

The process of radiative capture of heavy ions was successfully observed for the first time by means of the high-energy γ-radiation produced in the reactions $^{7}Li(^{16}O,\gamma)^{23}Na$, $^{11}B(^{12}C,\gamma)^{23}Na$, $^{6}Li(^{16}O,\gamma)^{22}Na$, $^{12}C(^{12}C,\gamma)^{24}Mg$, $^{12}C(^{16}O,\gamma)^{28}Si$ and $^{16}O(^{16}O,\gamma)^{32}S$. The $^{7}Li(^{16}O,\gamma)^{23}Na$ reaction was studied at $\theta = 90°$ for $E_x = 23-29$ MeV. A resonance-like structure was observed peaking at $E_x = 25.4$ MeV with a cm width of 0.67 ± 0.20 MeV ($d\sigma/d\Omega_{peak}$ 192 + 58 nb/sr). An angular distribution of the peak cross section can be fitted by $1 - (0.21 + 0.03)P_1$ or $1 - (0.15 + 0.10)P_3$. Possible explanations of this behavior are discussed. The $^{11}B(^{12}C,\gamma)^{23}Na$ reaction was studied at $\theta = 90°$ for $E_x = 23-27$ MeV. Only weak structure was observed. For the remaining reactions, uniformly low yields were observed with typical maximum cross sections of the order of $d\sigma/d\Omega = 30$ nb/sr for bombarding energies close to the respective Coulomb barriers. Particle spectra were measured for $^{7}Li + ^{16}O$ reactions emitting p, d, t, or α-particles corresponding to $E_x = 24.6-27.2$ MeV. Weak structure found in the various excitation curves is suggestive of compound nucleus formation in the reaction. (auth)

46919 HIGH-ENERGY PHOTOPROTONS FROM ^{12}C. Manuzio, G. (Univ., Genoa); Ricco, G.; Sanzone, M.; Ferrero, L. Nucl. Phys., A133: 225-36(1969).

The spectra of fast photoprotons from the reaction $^{12}C(\gamma,p)^{11}B$ have been measured at 14 bremsstrahlung end-point energies from 50 to 80 MeV. The main feature of the observed cross sections are compatible with a direct interaction of the photon with single nucleons. The experimental results are discussed in terms of momentum distribution of 1p and 1s protons between 1.5 fm^{-1} and 2.0 fm^{-1}. (auth)

46920 DIRECT AND INVERSE PHOTONUCLEAR REACTIONS ON ^{15}N AND ^{15}O. Zhusupov, M. A.; Eramzhyan, R. A. (Joint Inst. of Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 730-7(Apr. 1969). (In Russian).

Giant resonance studies were carried out on the mirror-image ^{15}N and ^{15}O nuclei and on their $I^{\pi} = 3/2^-$ states. The authors' previously described particle-hole approach was used for the calculations taking into effect the pair correlations of the nucleon in the nucleus. The inverse $^{14}N(p,\gamma)^{15}O$ and $^{14}C(p,\gamma)^{15}N$ photonuclear reactions were examined. The absorption cross section for quanta of ^{15}N and ^{15}O were expected to be identical although giant resonances in an inverse reaction for nuclei with an isospin other than 0 do not necessarily have transition cross sections which coincide. The experimental data indicated that the giant resonances under excited conditions has the same energy as at ground state and shifts toward the energy of the excited states. In the $^{14}C(p,\gamma)^{15}N$ inverse γ reaction only a small portion of the giant resonance was observed as very slight maximum at 30 MeV. In the $^{14}N(p,\gamma)^{15}O$ reaction no maximum was noted. (TTT)

46921 PHOTOSPALLATION OF ^{6}Li AND ^{7}Li BY γ BREMSSTRAHLUNG WITH AN $E_{\gamma max} = 12$ MeV. Sorokin, Yu. I.; Shardanov, A. Kh.; Shevchenko, V. G.; Yur'ev, B. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 721-5(Apr. 1969). (In Russian).

The spectrum of charged-particle emitted by ^{6}Li and ^{7}Li nuclei exposed to γ bremsstrahlung was determined, examining the $E_{\gamma max} = 12$ MeV range. The emitted reaction products were recorded by means of nuclear emulsion using the other previously described experimental method. The deuteron yield which in case of ^{6}Li amounted to less than 1% of the proton yield was neglected; similarly, tracks corresponding to proton energies below 2.4 MeV were not taken into account. Comparison of the integral excitation cross section of the levels of ^{6}Li in (γ,p) and (γ,n) reactions revealed unexpectedly that at $E_\gamma > 7.5$ MeV, the cross section of (γ,p_0) is about 10 times lower than that of the (γ,n) reaction. The translation-invariant model was used to study the photospallation of ^{6}Li in the case of the absorption of electric dipole radiation; the data agreed with E1 transition. The levels of ^{7}Li in the (γ,t) reaction and other nucleon-induced reactions were also determined; new levels were found at 6.3 ± 0.1 and 10.2 ± 0.2 MeV. Some earlier values were determined with a higher precision. (TTT)

46922 EFFECTS OF A SPIN–ORBIT POTENTIAL ON THE REACTION $^{12}C(d,\gamma)^{13}C$. Stieglitz, Robert Gwydir. Cleveland, Case Western Reserve Univ., 1968. 103p.

Thesis.

The distorted wave Born approximation (DWBA) is applied to the reaction $^{12}C(dp_{3/2})^{13}C$. A spin–orbit potential of the form $\bar{\sigma} \cdot \bar{l}\, V_{SO}(r)$, where $V_{SO}(r)$ is a form factor, is included in the optical potentials used to generate the elastic scattering wave functions for the deuteron and proton channels. Equations are presented for the elastic and reaction differential cross sections and polarizations. Equations are derived for the function $W(\theta_\gamma, \phi_\gamma, \theta_p)$ which expresses the correlation between the outgoing proton and the de-excitation gamma rays from $^{13}*C$ (3.68 MeV). A comparison is made with experiment at incident deuteron energies of 2.80, 3.23 and 3.70 MeV. The agreement between theory and experiment is only fair although it should be noted that there are several known resonances in the $^{12}C + d$ yield in the energy range studied. (Diss. Abstr.)

46923 EXCITATION OF THE $T = 3/2$ ANALOG STATES IN THE $(^{3}He,n)$ REACTION. Brill, O. D.; Vongai, A. D.; Ogloblin, A. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 615-17(Apr. 1969). (In Russian).

Reactions involving a 2^- nucleon transfer with nuclei of $T_z = \pm 1/2$ represent an efficient medium for the excitation of $T = 3/2$ analog states. For a better knowledge of this phenomenon, the neutron spectra of the $(^{3}He,n)$ reactions of ^{9}Be, ^{13}C, ^{25}Mg were measured in the expectation that the not yet observed $T = 3/2$ levels on ^{11}C,

^{15}O, and ^{27}Si nuclei will be observed. Similar measurements were made with $^{27}Al(^3He,n)^{29}P$ reaction for a check of the reported selected excitation of the known T = 3/2 level in the ^{29}P nucleus by this reaction. The ^9Be, ^{13}C, ^{25}Mg, and ^{27}Al type targets were irradiated by a He ion beam accelerated to 11.6 and 16.1 MeV. The spectrum of the $^{27}Al(^3He,n)^{29}P$ reaction exhibited the expected first T = 1/2 level of ^{29}P; thus, the $(^3He,n)$ reaction is sensitive with respect to the excitation of analog states. In the $^{13}C(^3He,n)^{15}O$ reaction a strong transition to the 11.5 ± 0.10 MeV level of the ^{15}O nucleus was noted; this probably corresponds to the anticipated analog state. (TTT)

46924 INVESTIGATION OF THE $(^7Li,\alpha)$ REACTION ON ^{16}O, ^{24}Mg, ^{27}Al, AND ^{28}Si. Glukhov, Yu. A.; Novatskii, B. G.; Ogloblin, A. A.; Sakuta, S. B.; Stepanov, D. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 609-14(Apr. 1969). (In Russian).

The $^{16}O(^7Li,\alpha)^{19}F$ reaction was investigated while obtaining preliminary results concerning the $(^7Li,\alpha)$ reaction on ^{24}Mg, ^{27}Al, and ^{28}Si at a ^7Li ion energy of 30.3 MeV. Tungsten oxide on a platinum support and self-supporting ^{24}Mg, aluminum, and silicon foils were used as targets. The spectrum, the angular distribution of α particles of the $^{16}O(^7Li,\alpha)^{19}F$ reaction, the ^{19}F levels and their excitation cross sections were determined. The important role of the sd shells in the excitation of clusters in nuclei was confirmed and was found to agree with earlier findings. It was also shown that the rotational bend of ^{19}F, based on the ground state and corresponding to the $(p)^{12}(sd)^3$ configuration may be considered a triton band; the deformation of the ^{19}F nucleus in its ground state, as that of ^{20}Ne, lead to a cluster character. The probability of forming a triton grouping was found to be much less in the heavier ^{27}Al, ^{30}P, and ^{31}P nuclei throughout the excitation energy range. (TTT)

46925 STUDY OF THE $(^6Li,\alpha)$ REACTION WITH ^{16}O AND ^{24}Mg. Davydov, V. V.; Ogloblin, A. A.; Sakuta, S. B.; Chuev, V. I. (Inst. of Atomic Energy, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 597-600(Apr. 1969). (In Russian).

The $(^6Li,\alpha)$ reaction was studied with ^{16}O and ^{24}Mg nuclei because they have been examined with respect to the (α,d) reaction, in which low levels of the residual nuclei are excited. The work was carried out with a 26-MeV doubly-charged ^6Li ion beam. Using a tungsten oxide layer on a gold foil and a 99% ^{24}Mg magnesium foil as targets. The $^{16}O(^6Li,\alpha)^{18}F$ and the $^{24}Mg(^6Li,\alpha)^{24}Al$ reactions were studied in the 0 to 40° range. Comparison with earlier studies revealed great differences in the relative excitation probabilities of the same states: levels which are strongly excited in (α,d) reactions were found to be weak in $(^6Li,\alpha)$ reactions and vice-versa. This indicates that in the (α,d) reaction no deuteron transfer according to the polar diagram of the dispersion theory takes place but proton and neutron are transferred. (TTT)

46926 $^{16}O(^6Li,d)^{20}Ne$ AND $^{16}O(^7Li,t)^{20}Ne$ REACTIONS. Gol'dberg, V. Z.; Davydov, V. B.; Ogloblin, A. A.; Sakuta, S. B.; Chuev, V. I. (Inst. of Atomic Energy, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 579-85(Apr. 1969). (In Russian).

Investigations of the $(^6Li,d)$ and $(^7Li,t)$ α-particle transfer reactions were extended to the ^{20}Ne nucleus. The experimental work was carried out in a beam of doubly-charged Li ions. The $(^6Li,d)$ reaction was studied at a lithium energy of 25.8 MeV and the $(^7Li,t)$ reaction at 30.3 MeV, measuring the excitation energy of the ^{20}Ne nucleus up to 16 or 17 MeV and the angular distribution within the 0 to 60° range. Tungsten oxide on a gold base served as the target. The results confirmed the conclusion of the earlier study that the fundamental mechanism in the $(^6Li,d)$ and $(^7Li,t)$ reaction consists in a direct transfer of α-particles as shown by the similarity of the excitation spectra. The 2^- (4.97 MeV) level which is forbidden by the selection rules was not found under any angle. The strong, 12.7-MeV transition may be related to the threshold effect. This level lies close to the threshold of the $(^{20}Ne \rightarrow {}^{12}C + 2\alpha)$ split and as the ground level of ^{16}O it contains a larger mixture of the $^{12}C + \alpha$ configuration, this level could be excited with great probability when α-particles are transferred to the ^{16}O nucleus. (TTT)

46927 $^{12}C(^6Li,d)^{16}O$ AND $^{12}C(^7Li,t)^{16}O$ REACTIONS. Gol'dberg, V. Z.; Davydov, V. V.; Ogloblin, A. A.; Sakuta, S. B.; Chuev, V. I. (Inst. of Atomic Energy, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 566-78(Apr. 1969). (In Russian).

Use of Li nuclei as bombarding particle is of great interest for the study of the mechanism of nuclear reactions. During the reaction an α particle, deuteron or triton is transferred to the target nucleus. The α-particle transfer reactions $(^6Li,d)$ and $(^7Li,t)$ are of special interest. Therefore ^{16}O, the traditional α-particle nucleus, was investigated. Doubly-charged Li atoms were used for the study of the $(^6Li,d)$ reaction at 25.8 and 36.5 MeV, and the $(^7Li,t)$ reaction at 28.2 and 30.3 MeV. The results indicated that the fundamental mechanism consisted in a direct transfer of the α particle leading to the preferential excitation of the α-particle states of the residual ^{16}O nucleus. They include the levels of the known rotational bands, starting with the 6.05 MeV, 0^+ state. A group of α-particle states was also observed at the range of the giant dipole resonance. There were indications that in some of its states, the ^{16}O nucleus has a 4-α-particle structure. (TTT)

46928 INVESTIGATION OF THE $(^3He,t)$ AND $(^3He,^3He')$ REACTIONS ON 1p SHELL NUCLEI. Ball, Gordon Charles. Berkeley, Calif., Univ. of California, 1968. 147p.

Thesis.

The $(^3He,t)$ and $(^3He,^3He')$ reactions on ^9Be, ^{12}C, ^{13}C, ^{14}C [$(^3He,t)$ reaction only], ^{14}N and ^{15}N were investigated at ^3He energies of 39.9, 49.8, 39.6, 44.8, 44.6 and 39.8 MeV, respectively. Angular distributions were obtained for all prominent states up to excitations of 20 MeV. A microscopic analysis of these data was carried out using a local two-body interaction with an arbitrary spin-isospin exchange mixture. Spectroscopic factors were calculated using intermediate-coupling wave functions for p shell states while simple j-j configurations were assumed for the levels which were populated by promoting a p nucleon to the s-d shell. A Yukawa interaction with a range of $\alpha^{-1} = 1.2$ F was found to give the best results. The strength of the effective nucleon–nucleon interaction required to fit these data is in good agreement with recent (p,p'), (p,n) and $(^3He,t)$ calculations on light nuclei. In particular, dominant L = 0 transitions observed in the $(^3He,t)$ reaction gave values for the isospin $V_{ST} = V_{01}$ and spin–isospin V_{11} dependent terms (converted to an effective nucleon–nucleon interaction at $\alpha^{-1} = 1.0$ F) of 20.6 and 16.5 MeV, respectively, while the strengths required to fit $(^3He,T)L = 2,3$ transitions were generally enhanced. For inelastic transitions, the average strengths obtained for V_{00}, assuming a Serber exchange mixture, varied from 47.2 to 67.3 MeV depending upon the L transfer involved. A comparison of the $(^3He,t)$ and $(^3He,^3He')$ reactions populating analog final states (where $T_f = T_i + 1$) is also presented. In general, these transitions were weakly populated; however, it was possible to observe the lowest T = 3/2 levels in the mirror nuclei $^9B-{}^9Be$ and $^{13}N-{}^{13}C$ and several T = 1 levels in $^{12}N-{}^{12}C$. (Diss. Abstr.)

46929 STUDIES IN THE 2s–1d SHELL USING TRITON INDUCED REACTIONS. Becker, J. A. (Lockheed Missiles and Space Co., Palo Alto, Calif.). pp 1-22 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18–20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.

See CONF-680440.

Some nuclear structure studies in the 2s–1d shell using triton induced reactions are described. Angular distributions and particle–γ coincidence spectra were measured for (t,α) reactions on ^{19}F, ^{24}Mg, ^{26}Mg, and ^{30}Si and (t,p) reactions on ^{27}Al, ^{26}Mg, ^{23}Na, ^{22}Ne, and ^{18}O. Level schemes are presented for ^{29}Al, ^{28}Mg, ^{23}Na, ^{25}Na, ^{24}Ne, ^{18}O, and ^{20}O. (J.W.R.)

46930 SHELL-MODEL CALCULATIONS IN THE 2s–1d SHELL. Halbert, E. C. (Oak Ridge National Lab., Tenn.). pp 128-66 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18–20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.

See CONF-680440.

Some shell-model calculations in the 2s–1d shell are described. In some of the calculations the full space for all states formed outside a closed 16-particle core was used, while in others a truncated space was used. The realistic interactions of Kuo and Kuo-Brown were used. The properties obtained included energy levels, spins and parities, transition probabilities, and spectroscopic factors. (J.W.R.)

46931 INVESTIGATION OF THE $(^7Li,\alpha)$ REACTION ON ^9Be AND ^{12}C. Glukhov, Yu. A.; Novatskii, B. G.; Ogloblin, A. A.; Sakuta, S. B.; Stepanov, D. N. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 601-8(Apr. 1969). (In Russian).

On the basis of earlier data it appears probable that triton transfer takes place in the $(^7Li,\alpha)$ reactions; therefore, this reaction may be used for the study of triton clusters in nuclei. This problem was investigated with the odd ^9Be and the even-even ^{12}C nuclei, using self-supporting foils as target material. It was expected that the formation of the triton group takes place differently in the residual ^{12}B and ^{13}N nuclei. A doubly-charged ^7Li ion beam accelerated to 30.3 MeV in the cyclotron was employed, measuring the angular distribution to 0°. The results indicated that a triton transfer mechanism is involved in the $(^7Li,\alpha)$ reaction and that triton states of the nuclei are excited. This was observed primarily at excitation energies above 8 MeV, near the effective triton thresholds. The excitation probability of the triton states is controlled by loss due to the completion of the sd shell with nucleons. The general character of

the excitation spectra of ^{19}B and ^{15}N is nearly identical; the structural differences of the ^{9}Be and ^{12}C target nuclei do not play an important role in the formation of triton clusters. (TTT)

46932 ELASTIC SCATTERING OF ^{3}He IONS ON LIGHT AND INTERMEDIATE NUCLEI. Artemov, K. P.; Gol'dberg, V. Z.; Rudakov, V. P. Yadern. Fiz., 9: 1173-6(June 1969). (In Russian).

Differential cross sections of elastic scattering of ^{3}He ions with the energy 36 MeV on the nuclei ^{12}C, ^{13}C, ^{20}Ne, ^{22}Ne, ^{27}Al, ^{28}Si, ^{52}Cr, and ^{58}Ni, ^{60}Ni, ^{62}Ni, and ^{64}Ni were measured. The measurements are analyzed on the basis of the nuclear optical model. It is shown that experimental distributions are satisfactorily described by a simple Saxon–Woods potential, the parameters of which are slightly changed from one nucleus to another. (auth)

46933 PHASE SHIFTS DURING PROTON SCATTERING ON ^{12}C AND ^{16}O. Soroka, V. I.; Pucherov, N. N. (Kiev Inst. of Physics). Ukr. Fiz. Zh., 14: 688-9(Apr. 1969). (In Russian).

A phase shift analysis of elastic proton scattering on ^{12}C and ^{16}O nuclei was made considering the differential cross sections and data on proton polarization during proton elastic scattering on oxygen (E_p = 2.5 MeV) and carbon (E_p = 3.5 MeV and E_p = 3.71 MeV). The analysis was carried out taking into account orbital moments of the number of motions up to l = 2. Tabulated data confirmed the high-sensitivity of polarization of elastically scattered on carbon, to the d-wave spallation. Data on oxygen at 2.5 MeV were in good agreement with published data. (R.V.J.)

46934 CROSS SECTION FOR THE REACTION $^{9}Be(n,d)^{8}Li$ BETWEEN 16,3 AND 18,7 MeV. Scobel, W. (Univ., Hamburg). Z. Naturforsch., 24a: 289-90(Feb. 1969). (In German).

The effective cross section of the reaction $^{9}Be(n,d)^{8}Li$, using neutrons from the $T(d,n)^{4}He$ reaction was measured by measuring the α particles of the ^{8}Li decay. A lattice ionization chamber in cylindrical geometry was used for the detection of the α particles. The energy spectrum of the ^{8}Li decay at a neutron energy of 18.22 MeV was given. The excitation function of the $^{9}Be(n,d)^{8}Li$ reaction was determined between 16.5 and 18.7 MeV, and the results are shown graphically. (J.S.R.)

46935 ANGULAR CORRELATIONS OF NEUTRONS IN (n,2n) REACTIONS ON BERYLLIUM, IODINE, AND BISMUTH NUCLEI. Prokopets, G. A.; Strizhak, V. I. (Kiev State Univ.). Ukr. Fiz. Zh., 14: 687-8(Apr. 1969). (In Russian).

Angular correlations of neutrons emitted by (n,2n) reactions on ^{9}Be, ^{127}I, and ^{209}Bi nuclei were measured at incidence neutron energy of 14 MeV. The relative probability of neutron emission from (n,2n) reaction was measured at θ_I in the direction of incidence neutrons, as a function of the angle fixed of the second neutron, and at θ_{II} in the direction of the incidence neutron. All three directions were distributed in the horizontal plane. Data obtained stressed the significance of the contributions of non-statistical processes to the (n,2n) reaction at primary neutron energy of 14 MeV. (R.V.J.)

46936 STUDY OF THE STRUCTURE OF ^{16}O ABOVE 25 MeV BY THE REACTION $^{13}C(\tau,\alpha)^{12}C^{*}(\gamma_{15.1})$. Tauber, M.; Hofmann, K.; Mausberg, W.; Roessle, E. (Univ., Freiburg i. B.). Z. Phys., 227: 71-7(1969).

The nucleus ^{16}O was investigated within the excitation range of 25 to 32 MeV by means of the reaction $^{13}C(^{3}He,\alpha)^{12}C^{*}_{15.1}(\gamma)^{12}C$. Excitation functions for the 15.1 MeV γ-rays, taken for bombarding energies $E_{^{3}He}$ = 2.6 to 12 MeV at 0° and 90°, exhibit some marked structures with widths of 0.5 to 1 MeV. As the $(^{3}He,\alpha)$-reaction leads to the 15.1 MeV, T = 1 state, levels in ^{16}O underlying these structures should have large T = 1 components. Angular distributions of the α-particles coincident to the 15.1 MeV γ-rays show patterns typical for a direct process and are, therefore, compared with DWBA calculations. (auth)

46937 DEUTERON SPALLATION IN IMPULSE APPROXIMATION. Berezhnoi, Yu. A.; Vinokurov, L. I. (Inst. of Physics and Tech., Kharkov). Ukr. Fiz. Zh., 14: 699-701(Apr. 1969). (In Russian).

The curves of differential cross sections of deuteron spallation on ^{27}Al nuclei at 94 MeV were calculated as functions of the angle of neutron emission ϑ_n with the curves constructed for the angle of proton emission: ϑ_p = 10°, ϑ_p = 30°, and ϑ_p = 50°. The differential cross sections for deuteron spallation at E_d = 94 MeV, ϑ_p = 10° for ^{27}Al, E_d = 156 MeV, ϑ_p = 10° for ^{12}C, and E_d = 420 MeV, ϑ_p = 10° for ^{12}C are included. (R.V.J.)

46938 HIGH RESOLUTION PROTON SCATTERING AT 100 MeV. Horowitz, Yigal S. Montreal, McGill Univ., 1968. Thesis.

The nuclei, ^{12}C, ^{24}Mg and ^{28}Si were studied by means of elastic and inelastic scattering of 100 MeV protons. A Ge(Li) detector long enough to stop 100 MeV protons in side-entry orientation was used as the total absorption proton counter. An overall energy resolution of 0.4 MeV (FWHM) was achieved. The experiment constitutes the first use of Ge(Li) detectors as total absorption counters for proton energies above 60 MeV. The measurements cover an angular region from 10 to 60° and excitation energies up to 16.5 MeV. Angular distributions were extracted for 35 peaks in the energy spectra. Shapes of angular distributions for 0+ – 2+ and 0+ – 3⁻ transitions appear energy and shell independent however significant differences exist for 0+ – 0+ and 0+ – 4+ transitions. A comparison of proton inelastic scattering and radiative decay rates is presented as well as an optical model analysis of the elastic scattering. The excitation of a previously unknown level in ^{28}Si at an excitation energy of 11.45 ± 0.12 MeV with $J^{\pi} = 5^{-}$ was observed. The level may be the 5⁻ level belonging to the K = 3⁻ band in ^{28}Si. (Diss. Abstr.)

Nuclear Properties and Reactions, 20 ≤ A ≤ 89

Refer also to abstracts 46564, 46923–46926, 46929, 46930, 46932, 46937, 46938, 46977, 46985, 47036, 47047, and 47063.

46939 (BNL-tr-283) NONCONSERVATION OF PARITY IN γ DECAY OF ^{41}K. Lobashov, V. M.; Lozovoi, N. A.; Nazarenko, V. A.; Smotritskii, L. M.; Kharkevich, G. I. (Akademiya Nauk SSSR, Leningrad. Fiziko-Tekhnicheskii Institut). Translation of a Russian Report. 12p. Dep. CFSTI.

The circular polarization of the γ quanta of the 1290 keV transition in ^{41}K following the β decay of ^{41}Ar ($T_{\frac{1}{2}}$ = 109 min.) was measured. The ^{41}Ar source was prepared by irradiating gaseous argon in a high pressure loop in the reactor and subsequently liquefying the active gas in the source assembly. A transmission type polarimeter with a total registration of γ quanta and with resonance separation and storage of the periodic signal was used to measure the circular polarization. A circular polarization of the γ quanta equal to $P_\gamma = +(1.9 \times 0.3) \times 10^{-5}$ was observed. (auth)

46940 (COO–1549-15) NUCLEAR PHYSICS STUDIES USING NUCLEAR EMULSIONS. Technical Progress Report, November 6, 1968–October 31, 1969. (Wyoming Univ., Laramie). Aug. 10, 1969. Contract AT(11-1)-1549. 48p. Dep. CFSTI.

ALPHA PARTICLES—reactions with copper-63 and nickel-60 at 31.3 MeV, neutron spectra and angular distributions for, (E)
—energy spectra of, effects of thickness on resolution of E – de/dx spectrometer for measuring
COPPER-63—proton reactions at 26 MeV, neutron spectra and angular distributions for, (E)
—alpha reactions at 31.3 MeV, neutron spectra and angular distributions for, (E)
DEUTERONS—energy spectra of, effects of thickness on resolution of E – de/dx spectrometer for measuring
GAMMA RADIATION—detection using lithium-drifted germanium detectors, absolute efficiency for
HELIUM-3—reactions with zinc-64 and -66 at 37.7 MeV, excitation functions and relative yields for, (E)
—energy spectra of, effects of thickness on resolution of E – de/dx spectrometer for measuring
NICKEL-60—proton reactions at 26 MeV, neutron spectra and angular distributions for, (E)
—alpha reactions at 31.3 MeV, neutron spectra and angular distributions for, (E)
OILS—analysis of crude, for vanadium by neutron activation and scintillation counting
PROTONS—reactions with copper-63 and nickel-60 at 26 MeV, neutron spectra and angular distributions for, (E)
—energy spectra of, effects of thickness on resolution of E – de/dx spectrometer for measuring
RADIATION DETECTORS, SEMICONDUCTOR (GERMANIUM)—efficiency of lithium-drifted, for gamma spectroscopy
SPECTROMETERS—resolution of E – de/dx charged-particle, effects of thickness on
TRITONS—energy spectra of, effects of thickness on resolution of E – de/dx spectrometer for measuring
VANADIUM—determination in crude oil by neutron activation and scintillation counting
ZINC-64—helium-3 reactions at 37.7 MeV, excitation functions and relative yields for, (E)
ZINC-66—helium-3 reactions at 37.7 MeV, excitation functions and relative yields for, (E) (L.T.W.)

46941 (NP-17979) CALCULATIONS OF TOTAL MUON CAPTURE RATES IN NUCLEI. Luyten, Jan Reindert (Groningen Rijksuniversiteit (Netherlands)). 1968. 143p. Dep.

Thesis.

The basic starting points for the calculation of muon capture rates in nuclei are discussed. The Universal Fermi Interaction hypothesis for muon capture is examined. Muon capture rates for ^{16}O, ^{40}C, ^{48}C, ^{50}Ti, ^{52}Cr, and ^{54}Fe are calculated and compared with experimental values. Some details of nuclear structure and the muon capture distribution obtained as a by-product in the calculation are presented. (J.W.R.)

46942 (NYO-3417-11) PROGRESS REPORT [ON RADIO- AND RADIATION CHEMISTRY], SEPTEMBER 16, 1968-SEPTEMBER 16, 1969. Finston, Harmon L. (Brooklyn Coll., N. Y. Dept. of Chemistry). June 30, 1969. Contract AT(30-1)-3417. 18p. Dep. CFSTI.

Progress is reported on: direct determination of fast neutron cross sections, thermal neutron capture cross sections of (n,2n)-produced radionuclides, and application of radioreagents. (M.C.G.)

46943 (ORNL-4382) GAMMA-RAY SPECTRA ARISING FROM THERMAL-NEUTRON CAPTURE IN ELEMENTS FOUND IN SOILS, CONCRETES, AND STRUCTURAL MATERIALS. Maerker, R. E.; Muckenthaler, F. J. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 264p. Dep. CFSTI.

Gamma-ray spectra arising from the capture of thermal neutrons are presented for iron, aluminum, copper, zinc, titanium, nickel, silicon, calcium, potassium, sodium, barium, chlorine, sulfur, and stainless steel. The spectral intensities in photons per 100 captures are presented as both individual lines and as sums of these lines over 0.5-MeV intervals which are intended for use in shielding calculations. The latter results have an estimated accuracy of ±15%, and include the contributions from both discrete and continuum gamma rays. Comparisons of these spectra are made with previously determined spectra, as well as with values reported in the Reactor Handbook, and considerable revision in the latter is concluded to be necessary. The present results do not go below 1 MeV, but when the relatively small contributions from energies less than 1 MeV are added to them, binding energy checks within ±5% are obtained. (auth)

46944 (RCN-105) EXPERIMENTS WITH POLARIZED THERMAL NEUTRONS. Abrahams, K. (Reactor Centrum Nederland, Petten). May 1969. 55p. Dep.

This report describes the development of a mirror system, installed at the H.F.R., giving an intense beam of polarized thermal neutrons. In addition, some experiments performed with this system are described. In two introductory chapters a more general survey is given of nuclear physics experiments with polarized thermal neutrons and of the methods to produce these neutrons. After a treatment of the mirror system in the third chapter, the measurement of the circular polarization of capture γ radiation is presented in the last chapter. From the results it was possible to assign spin values to excited states in ^{40}K, ^{41}Ca, ^{49}Ti, ^{60}Co, ^{114}Cd and ^{208}Pb. (auth)

46945 (UCRL-71829) THRESHOLD PHOTONEUTRON CROSS SECTION FOR ^{26}Mg AND A SOURCE OF STELLAR NEUTRONS. Berman, B. L.; Van Hemert, R. L.; Bowman, C. D. (California Univ., Livermore. Lawrence Radiation Lab.). June 27, 1969. 5p. (CONF-690816-2). Dep. CFSTI.

From Gordon Conference for Photonuclear Reactions, Tilton, N. H.

The differential cross section at 135° for the $^{26}Mg(\gamma,n)$ reaction was measured for bremsstrahlung of 11 to 13 MeV endpoint energies using the threshold photoneutron technique. The discovery of a prominent neutron peak at 54.3 keV might have important astrophysical implications as a source of neutrons in stars via the $^{22}Ne + \alpha \rightarrow {}^{26}Mg \rightarrow {}^{25}Mg + n$ reaction. (J.W.R.)

46946 COULOMB EXCITATION OF ^{28}Si PROJECTILES. Haeusser, O. (Chalk River Nuclear Labs., Ontario); Alexander, T. K.; Pelte, D.; Hooton, B. W.; Evans, H. C. Phys. Rev. Lett., 23: 320-3(Aug. 11, 1969).

The static quadrupole moments of the first excited $J^\pi = 2^+$ states in ^{28}Si and ^{62}Ni were measured to be $Q = 0.17 \pm 0.05$ and $Q = 0.08 \pm 0.12$ b, respectively, using the reorientation effect in Coulomb excitation with 70-MeV ^{28}Si projectiles incident on a ^{62}Ni target. (auth)

46947 EVIDENCE FOR Y_4 DEFORMATION IN ^{20}Ne AND OTHER s-d SHELL NUCLEI. de Swiniarski, R.; Glashausser, C.; Hendrie, D. L.; Sherman, J.; Bacher, A. D.; McClatchie, E. A. (Univ. of California, Berkeley). Phys. Rev. Lett., 23: 317-20 (Aug. 11, 1969).

The sign and magnitude of the hexadecapole deformation in ^{20}Ne is determined from measurements of the inelastic scattering of 24.5-MeV protons. A coupled-channels analysis yields a value for β_4 of +0.28. A similar analysis of other available data in the s-d shell suggests a large hexadecapole deformation in ^{28}Si (+0.25) and ^{32}S (+0.25); ^{24}Mg is found to have a Y_4 moment close to zero. (auth)

46948 PROTON TRANSFER ON ^{50}V VIA THE (^3He,d) REACTION. Dorenbusch, W. E.; Belote, T. A.; Rapaport, J. (Massachusetts Inst. of Tech., Cambridge). Contract AT(30-1)-2098. Nucl. Phys., A133: 146-60(1969).

The $^{50}V(^3He,d)^{51}Cr$ reaction has been investigated at an incident energy of 7.5 MeV. Angular distributions were measured in the MIT multiple-gap spectrograph and analyzed in the distorted-wave Born approximation. The Q-value for the ground state transition was measured to be 4.031 ± 0.015 MeV. Transitions to 44 excited states were observed below 6.0 MeV of excitation. The low-lying part of the ^{51}Cr level scheme is discussed in terms of the shell model and the Coriolis coupling model. (auth)

46949 ANALOG STATES IN ^{35}Cl. Kopanets, E. G. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 711-13(Apr. 1969). (In Russian).

Only a slight amount of isotopic spin mixing is noted in the 1d2s shell; therefore, the analog states are pure or mixed with a small number of neighboring states. These states exhibit resonance intensities in the (p,γ) type reactions, corresponding to one-particle analog states, which are much larger than the intensity of neighboring resonances. This problem was further studied by extending earlier investigations of the excited levels of the ^{35}Cl nucleus. The 7.55- and 7.84-MeV excitation levels of ^{35}Cl are analogs of two levels of ^{35}S. The result in the $^{34}S(p,\gamma)^{35}Cl$ reaction is of special interest: the 8.38-MeV level of ^{35}Cl is an analog of the 2.96-MeV level of the ^{35}S nucleus and has a spin and parity $I^\pi = 5/2^-$, an isospin $T = 3/2$ and its "antianalog" state, the 4.0-MeV state of ^{35}Cl has a spin and parity of $I^\pi = 5/2^-$ and an isospin $T = 1/2$. As these two states have the same configuration, the energy splitting may be due to the interaction of the isotopic spin of the nucleon and the isospin of the whole nucleus, allowing to calculate the constant of interaction. (TTT)

46950 (^7Li,t) AND (^6Li,d) REACTIONS ON ^{20}Ne, ^{24}Mg, ^{28}Si, AND ^{40}Ca. Gol'dberg, V. Z.; Davydov, V. V.; Ogloblin, A. A.; Sakuta, S. B.; Chuev, V. I. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 586-96(Apr. 1969). (In Russian).

Studies of α-particle states in the ^{16}O and ^{20}Ne nuclei was extended to other 4n type nuclei in order to determine to what extent the α-particle structure is conserved in the $(sd)^8$ and $(sd)^{12}$ configurations which correspond to the rotational levels of ^{24}Mg and ^{28}Si. The study of the (^6Li,d) and (^7Li,t) reactions on ^{40}Ca is of interest because the newly formed ^{44}Ti nucleus consists of a doubly magic core plus an α particle and is similar in this respect to the ^{20}Ne nucleus. A ac, doubly-charged Li beam was used for the study of the (^6Li,d) reaction on ^{24}Mg, ^{28}Si, and ^{40}Ca at 25.8 MeV and the (^7Li,t) reaction at 30.3 MeV on ^{20}Ne, ^{24}Mg, ^{28}Si, and ^{40}Ca at angles from 0 to 30°. It was found that most intensive reactions were related with the formation of α-particle states of the nuclei occur at excitation energies higher than 10 MeV. The $0^+ -2^+ -4^+ -6^+$ bands of ^{24}Mg and ^{28}Si nuclei are not α-particle bands and thus differ from the corresponding bands of ^{16}O and ^{20}Ne nuclei. (TTT)

46951 INELASTIC SCATTERING OF PROTONS BY ^{26}Mg. Koval, A. A.; Kopanets, E. G.; Ievlev, Yu. P.; Tsytko, S. P. (Physico-Technical Inst., Kiev). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 704-10(Apr. 1969). (In Russian).

In order to study the higher levels of the ^{27}Al nucleus, the $^{26}Mg(p,p'\gamma)^{26}Mg$ reaction was examined in the proton energy range of $E_p = 3.0$ to 3.6 MeV, corresponding to an excitation energy of 11.15 to 11.77 MeV of the ^{27}Al nucleus. Thirty-seven previously unobserved resonances were found in this range; for 24 of them the angular distribution of the 182-MeV γ rays with respect to the direction of the incident protons was measured. An electrostatic accelerator was used as the accelerated-proton source, using a current integrator for control. The results allowed estimation of the spin and parity of the excited levels of the ^{27}Al nucleus. It was possible to show again that the resonance states of ^{27}Al are analogs with the levels of ^{27}Mg on the basis of isospin; doublets and triplets of the two nuclei are analogs, as has been noted by D. M. Sheppard et al. (TTT)

46952 INVESTIGATION OF LOW-LYING STATES IN NUCLEI OF THE 2s-1d SHELL USING (p,d) AND (p,t) REACTIONS. Anderson III, Albert Sydney. Stanford, Calif., Stanford Univ., 1968. 84p.

Thesis.

The low-lying states of various nuclei in the 2s-1d shell were investigated to obtain their structural parameters and to evaluate their theoretically predicted wave functions. A particle identification system utilizing on-line computer techniques was constructed which identifies reaction products in real time over an energy range of 1 to 20 MeV. It consists of a counter telescope

with two solid state detectors, amplyfying electronics, a dual 4096 channel analyzer, and PDP-7 computer. This system was used to observe the reactions $^{19}F(p,d)^{18}F$, $^{19}F(p,t)^{17}F$, and $^{39}K(p,d)^{38}K$ at proton energies of 16 MeV and 18 MeV, and $^{23}Na(p,d)^{22}Na$, $^{27}Al(p,d)^{26}Al$, and $^{31}P(p,d)^{30}P$ at 16 MeV. Angular distributions of deuterons and tritons representing the states in the residual nuclei were recorded. Overall energy resolution in the deuteron and triton spectra was 60 keV. The maximum excitation energy of the states analyzed was 3.36 MeV in ^{18}F, 3.86 MeV in ^{17}F, 3.06 MeV in ^{22}Na, 2.55 MeV in ^{26}Al, 2.94 MeV in ^{30}P, and 2.40 MeV in ^{38}K. Characteristic pickup reaction shapes were evident in almost all the differential cross sections, and the effect of the deformed target and residual nuclei was seen as an increase in the amount of backscattering expected. The l values of the transferred neutrons were successfully assigned in 41 out of the 44 residual states studied. Based on these l values, the recent observations of negative parity for the 1.08-, 2.10-, and 3.13-MeV states in ^{18}F and 2.21-MeV state in ^{22}Na were confirmed. Positive parity was assigned to the 2.72- and 2.84-MeV levels in ^{30}P. Also for ^{22}Na, a tentative assignment of negative parity was suggested for the 2.57- and 2.97-MeV levels and a tentative assignment of positive parity was proposed for the 3.06-MeV level. No further analysis was attempted for the triton differential cross sections. For the deuterons, spectroscopic factors for the residual states were extracted by DWBA analysis of the data. The factors for $E_p = 18$ MeV were consistent with the factors obtained at $E_p = 16$ MeV. The experimental spectroscopic factors were compared with various theoretical predictions. The results show support for the interpretation of the structure of ^{22}Na in terms of rotational states. The results for ^{26}Al are consistent with such an interpretation but do not show as good agreement. For the remaining nuclei, the results indicate that the parameterizations of the residual interaction strengths of Glaudemans et al., for ^{30}P and ^{38}K and by Inoue et al., for ^{18}F are inadequate for predicting configuration mixing in this shell. (Diss. Abstr.)

46953 PRODUCTION AND DECAY OF ^{43}Ar AND ^{44}Ar. Larson, R. E.; Gordon, C. M. (Naval Research Lab., Washington, D. C.). Nucl. Phys., A133: 237-40(1969).

Investigation of the photoproduction of isotopes of geochemical and oceanographic interest has resulted in the production of two previously unreported isotopes of argon. Calcium oxide, enriched to 97.16% ^{48}Ca, was irradiated with thick target bremsstrahlung at end-point energies of 39, 46 and 55 MeV. Production of previously unreported ^{44}Ar with a half-life of 14.0 ± 1.5 min by the $^{48}Ca(\gamma,\alpha)^{44}Ar$ reaction was confirmed by the growth of ^{44}K. Spectral evidence indicating the presence of ^{43}Ar was also found. Relative photonuclear yields were measured. The energy of the observed gamma ray from the decay of ^{44}Ar was measured as 1886.5 ± 0.8 keV. A gamma ray with an energy of 975.6 ± 1.1 keV and a half-life of 6.5 ± 1.8 min was tentatively attributed to ^{43}Ar. (auth)

46954 SEARCH FOR WEAKLY POPULATED STATES IN THE DECAY OF ^{51}Cr. Kluk, A. F.; Krmpotic, D.; Hamilton, J. H. (Vanderbilt Univ., Nashville). Z. Phys., 227: 78-82(1969).

A low level counting facility equipped with two large NaI(Tl) detectors was used to search for previously reported transitions of 470 and 640 keV in the decay of ^{51}Cr. Results yield upper limits of 1.4×10^{-6} and 0.95×10^{-6} transitions/decay for these two transitions, respectively. These limits are now so low as to indicate these levels do not exist in ^{51}V. (auth)

46955 GAMMA-RAY SPECTROSCOPY IN LIGHT NUCLEI: ^{22}Na, AN EXAMPLE. Olness, J. W. (Brookhaven National Lab., Upton, N. Y.). pp 192-229 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18-20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.
See CONF-680440.

The advantages to be gained by a broad application of some techniques of γ-ray spectroscopy in nuclear structure studies on light nuclei are illustrated by some studies on ^{22}Na. The studies include high-resolution measurements of γ spectra using Ge(Li) detectors, beta decay of ^{22}Mg to ^{22}Na, and angular correlation measurements. (J.W.R.)

46956 GAMMA DECAY OF ANALOGUE STATES IN THE 2s-1d SHELL. Endt, P. M. (Univ., Utrecht). pp 73-87 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18-20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.
See CONF-680440.

It is shown that the strong M1 analog to anti-analog transitions in the s-d shell are more complicated than previously suggested. The gamma decay of analog and anti-analog states in ^{38}Ar is examined in detail. The use of Doppler shift attenuation measurements in investigating gamma transition probabilities is discussed. (J.W.R.)

46957 T = 2 LEVELS IN ^{20}Ne, ^{24}Mg, AND ^{32}S AS COMPOUND-NUCLEUS RESONANCES. Hanna, S. S.; Riess, F.; O'Connel, W. J.; Snover, K. A.; Kuan, H. M.; Heikkinen, D. W.; Latshaw, G. L.; Adelberger, E.; Nero, A. V. (Stanford Univ., Calif.). pp 88-91 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18-20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.
See CONF-680440.

The observation of T = 2 resonances of ^{20}Ne, ^{24}Mg, and ^{32}S as compound-nucleus resonances in $(p,\gamma\gamma)$ reactions is reported. (J.W.R.)

46958 THE MIRROR NUCLEI ^{25}Mg AND ^{25}Al. Litherland, A. E. (Univ. of Toronto). pp 92-123 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18-20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.
See CONF-680440.

Recent experimental studies of the mirror nuclei ^{25}Al and ^{25}Mg are discussed in detail. (J.W.R.)

46959 GAMMA DECAY OF STATES IN ^{25}Al. Bearse, R. C. (Argonne National Lab., Ill.). pp 124-7 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18-20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.
See CONF-680440.

Gamma-ray decay studies were made of some ^{25}Al states which are the $T = 3/2$ analogs of the ground and first excited states of ^{25}Na. The levels were populated through the $^{24}Mg(p,\gamma)$ reaction. The level scheme is compared with the Nilsson model. (J.W.R.)

46960 THEORY AND EXPERIMENT IN 2s-1d SHELL NUCLEI. Ripka, G. (Princeton Univ., N. J. Rutgers-The State Univ., New Brunswick, N. J.). pp 167-87 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18-20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.
See CONF-680440.

Some experimental data on 2s-1d shell nuclei are reviewed and compared with theory. Discrepancies in the ^{28}Si region are discussed. (J.W.R.)

46961 STUDY OF ^{57}Fe NEUTRON RESONANCES. Rohr, G.; Mueller, K.-N. (Kernforschungszentrum, Karlsruhe, Ger.). Z. Phys., 227: 1-17(1969). (In German).

The total neutron cross section of ^{57}Fe in the keV region was measured in a transmission experiment using a pulsed Van de Graaff generator. Experimental data were fitted with a two channel multilevel formula to obtain the individual resonance parameters including the inelastic scattering width. The strength-function and its spin dependence are investigated. The data indicate a correlation between the phases of the reduced amplitudes for elastic and inelastic scattering. In a further experiment the 14.4 keV-γ-radiation of the $(n,n'\gamma)$-reaction in ^{57}Fe was detected. The application of this reaction for Moessbauer experiments is discussed. (auth)

46962 HIGH-ENERGY γ RADIATION OF ^{48}V. Ardisson, G.; Ythier, C. (Faculte des Sciences, Nice). Physica, 41: 510-14 (Mar. 7, 1969). (In French).

Gamma radiation from ^{48}V was studied with the aid of a pair spectrometer. Two new gammas were observed at 2375.6 and 2421.7 keV, and interpretations for each are proposed. (tr-auth)

46963 THE $1f_{\frac{7}{2}}$ PROBLEM IN NUCLEAR SPECTROSCOPY. Ricci, R. A. (Univ., Padua. Istituto Nazionale di Fisica Nucleare, Padua); Maurenzig, P. R. Riv. Nuovo Cim., 1: 291-354(Apr.-June 1969).

A review is presented on the current descriptions of nuclear structure in the $1f_{\frac{7}{2}}$ shell. The experimental data are surveyed and discussed in terms of the current theoretical approaches. (117 references). (J.W.R.)

46964 THRESHOLD PHOTONEUTRON CROSS SECTION FOR ^{26}Mg AND A SOURCE OF STELLAR NEUTRONS. Berman, B. L.; Van Hemert, R. L.; Bowman, C. D. (Univ. of California, Livermore). Phys. Rev. Lett., 23: 386-9(Aug. 18, 1969).

The differential photoneutron cross section for ^{26}Mg at 135° was measured as a function of photon energy from 10 keV to 1.5 MeV above threshold by the threshold photoneutron technique. Several prominent resonances were observed, including one located at 54.3 keV above threshold. The existence of this resonance in the ^{26}Mg compound system might provide, through the reaction $^{22}Ne(\alpha,n)^{25}Mg$, the primary production mechanism for neutrons in stars. (auth)

46965 STUDY OF γ RAY COINCIDENCES FROM REACTION $^{44}Ca(n,\gamma)^{45}Ca$. Bogdanov, A. P.; Rudak, E. A.; Soroka, A. V.; Tadeush, V. N; Firsov, E. I. (Inst. of Physics, Minski). Yadern. Fiz., 10: 31-2(July 1969). (In Russian).

The scheme of transitions of the ^{45}Ca nucleus resulting from the capture of thermal neutrons was studied by the $\gamma\gamma$-coincidence method. Direct transitions from initial state to the levels 0.18, 1.43, 1.90, 2.25, 2.85, and 3.43 MeV were found. The data for decay of these levels are given. (auth)

46966 ELECTROEXCITATION OF LOW-ENERGY COLLECTIVE STATES IN ISOTOPES OF $^{58\ 60\ 64}Ni$. Afanas'ev, V. D.; Afanas'ev, N. G.; Gul'karov, I. S.; Savitskii, G. A.; Khvastunov, V. M.; Shevchenko, N. G.; Khomich, A. A. (Kharkov State Univ.). Yadern. Fiz., 10: 33-43(July 1969). (In Russian).

Form factors of quadrupole and octupole transitions with the energies 1.45 and 4.45 MeV, 1.33 and 4.04 MeV, 1.32 and 3.55 MeV were measured in the nuclei of ^{58}Ni, ^{60}Ni, and ^{64}Ni, respectively, at initial electron energy 150 and 225 MeV. Reduced probabilities of transitions, transition radii and the parameters B_λ, C_λ, and β_λ^q of the vibration model, were determined. (auth)

46967 CROSS SECTIONS OF REACTIONS (n,p) AND (n,α) AT 14.8 MeV NEUTRON ENERGY. Levkovskii, V. N.; Vinitskaya, G. P.; Kovel'skaya, G. E.; Stepanov, V. M. (Inst. of Nuclear Physics, Alma-Ata, USSR). Yadern. Fiz., 10: 44-6(July 1969). (In Russian).

Thirty-four absolute cross sections of the (n,p) and (n,α) reactions on the isotopes of Ti, V, Ni, Zr, Nb, Ag, In, Sn, and I were measured by the activation method. (auth)

46968 HALF-LIFE TIMES OF ^{75}As EXCITED LEVELS. Azimov, K. Sh.; Begzhanov, R. B.; Gladyshev, D. A.; Isakov, B. (Inst. of Nuclear Physics, Tashkent). Yadern. Fiz., 10: 3-6 (July 1969). (In Russian).

Half-lives of three excited levels in ^{75}As were measured by the method of delayed $\gamma\gamma$ coincidences. Probabilities of different γ transitions which are compared with predictions of the Davydov's odd nuclei model, are determined. (auth)

46969 STUDY OF 1290 keV LEVEL DECAY OF ^{53}Mn NUCLEUS. Abuzeid, M. A.; Zaiki, M. I.; Mansur, N. A.; Saad, Kh. R.; Popov, A. I.; Storizhko, V. E. Yadern. Fiz., 10: 7-13(July 1969). (In Russian).

Triple $\gamma\gamma$ correlations for the cascade 1290 → 380 → 0 in the ^{53}Mn nucleus were measured. The 1290-keV level was populated in the reaction $^{52}Cr(p,\gamma)^{53}Mn$ at E_p = 1.0 to 2.5 MeV. The measurements are performed in I, II, VI, and VII geometries (in terms of Ferguson). Analysis of the angular correlations (I is the method of Ferguson and Litherland for aligned nuclei) allows one to determine the mixture coefficients of multipoles for γ transitions with the energies 910 keV ($\delta_1 = -0.09 \pm 0.06$) and 380 keV ($\delta_2 = -0.47 \pm 0.10$). (auth)

46970 ENERGY-DEPENDENT COHERENCE WIDTH OF ^{28}Si AT EXCITATION ENERGIES BETWEEN 22 AND 33 MeV. Roeders, J. D. A. (Univ., Groningen, Netherlands), Put, L. W.; Drentje, A. G.; van der Woude, A. Nuovo Cim., Lett., 2: 209-13(Aug. 11, 1969).

Excitation functions and differential cross sections were measured for alpha elastic and inelastic scattering by magnesium-24 at 18 to 27 MeV. The data were analyzed to determine the energy dependence of the coherence width for the ^{28}Si compound-nucleus levels at 22 to 33 MeV excitation energies. (J.W.R.)

46971 L/K CAPTURE RATIO OF ^{65}Zn. Huster, E.; Krafft, O. (Univ., Muenster, Ger.). Z. Naturforsch., 24a: 285(Feb. 1969). (In German).

The L/K capture ratio of ^{65}Zn was measured by the Drever and Moljk measurement method using a partitionless proportional counter. $^{65}Zn(C_2H_5)_2$, added in vapor form to the filling gas of argon + 10% methane, was used as the measurement preparation. The L/K capture ratio P_L/P_K was measured jointly for both the electron-capture decay to the ground state of ^{65}Cu and to an excited level of ^{65}Cu at 1.114-MeV. The transition to the excited state was measured alone in coincidence with the 1.114-MeV γ radiation. The value obtained for both transitions measured jointly was $P_L/P_K = 0.118 \pm 0.003$. The value obtained for the transition at 1.114 MeV was 0.120 ± 0.003. These values were compared with previous experimental and theoretical results. (J.S.R.)

46972 NUCLEAR SPIN-SPIN EFFECT IN THE TOTAL CROSS SECTION FOR 1 MeV POLARIZED NEUTRONS ON POLARIZED ^{59}Co NUCLEI. Nagamine, Kaetada; Uchida, Akira (Tokyo Univ.). Tech. Rep. ISSP (Inst. Solid State Physics), Ser. A, No. 371, 59p (July 1969).

Measurements of the spin-spin effect, $\sigma_{ss} = (\sigma\uparrow\uparrow - \sigma\uparrow\downarrow)/2P_n \cdot P_t$, in the total cross section for polarized neutrons on polarized ^{59}Co are reported at the neutron energies of 1.1 and 1.4 MeV. The degree of target polarization from 0.47 to 0.30 was obtained for a polycrystalline metal of $Co_{0.90} - Fe_{0.10}$ alloy at demagnetization temperatures from 0.030 to 0.048°K. The results of σ_{ss} are -190 ± 140 mb at 1.1 MeV and -150 ± 180 mb at 1.4 MeV. If σ_{ss} is assumed to arise from a spin-spin term in the optical potential of the form $-V_{ss} f(r)\vec{\sigma} \cdot \vec{I}$, the strength of the potential is 200 keV < V_{ss} < 800 keV combining with the published data for σ_{ss} at 7.90 MeV and assuming f(r) as a microscopic form factor. A weak and attractive nature of the spin-spin interaction is qualitatively explained by a microscopic model. (NSA of Japan)

46973 INELASTIC SCATTERING OF 17.5 MeV PROTONS FROM ^{51}V, ^{52}Cr, ^{55}Mn, AND ^{56}Fe. Peterson, R. J. (Princeton Univ., N. J.). Ann. Phys. (N. Y.), 53: 40-92(June 1, 1969).

The elastic and inelastic scattering of 17.5-MeV protons from ^{51}V, ^{52}Cr, ^{55}Mn, and ^{56}Fe was studied, and excitation energies, spins, and collective strength parameters are obtained. The present results are compared to a variety of previous measurements from inelastic scattering studies. Several simple nuclear models are used to generate predictions for the odd-A targets in terms of the data for the even-A targets. The seniority shell model describes the low-lying excited states of ^{51}V quite well, and a strong-coupling rotational model for ^{55}Mn was found to be inadequate. (auth)

46974 GIANT DIPOLE RESONANCE OF ^{44}Ti. Cherdantsev, P. A.; Bazhenov, A. A. (Tomsk Polytechnic Inst., USSR). Izv. Vyssh. Ucheb. Zaved., Fiz., No. 5, 147-9(1969). (In Russian).

Giant dipole resonance was studied in the even-even nucleus ^{44}Ti with deformation parameter $\delta = 0.6$. The basis for the expansion of dipole state functions was selected as: $\psi^1_{MK} = \Sigma_1 D_1 \phi^1_{M_1K_1} \psi^1_{mk}$ where $\phi^1_{M_1K_1}$ is a normalized antisymmetric wave function of 4 external nucleons, ψ^1_{mk} is a function of partial-gap pairs. The analysis was limited to partial-gap interactions with a deformed potential. The type of interactions selected was $V = -g[(\alpha - 1) - \alpha\sigma_p\sigma_h]\delta(r_p - r_h)$. The interaction constants were taken from photoabsorption on ^{40}Ca and were equal to: g = 900 MeV and $\alpha = 0.15$. Diagrams are included for the oscillator forces as functions of energy in a single particle, diagonal, and quasidiagonal approximation. (R.V.J.)

46975 ELASTIC AND INELASTIC SCATTERING OF ALPHA PARTICLES BY ^{27}Al IN THE ENERGY RANGE FROM 12 TO 16 MeV. Ivascu, M.; Semenescu, G.; Bucurescu, D.; Titirici, M. (Inst. of Atomic Physics, Bucharest). Rev. Roum. Phys., 14: 129-37(1969).

Elastic and inelastic scattering of 12.1, 13.6, 14.9 and 16.0 MeV alpha particles by ^{27}Al was studied. The elastic angular distributions obtained at 14.9 and 16.0 MeV were analyzed using the Blair model, as well as the diffractional model proposed by Inopin. The last model was also used to fit the inelastic cross-sections for the low excited states, at 16 MeV incident energy. The results show that for energies greater than 15 MeV the predominant interaction mechanism is the direct interaction; below this energy, the compound nucleus mechanism has a considerable contribution. (auth)

46976 MEASUREMENT OF THE MEAN LIFE OF THE 4.49-MeV (5^-) STATE OF ^{40}Ca. EFFECTS OF DEFORMED COMPONENTS ON THE LIFETIMES OF THE ODD-PARITY STATES. MacDonald, Jack R. (Bell Telephone Labs., Murray Hill, N. J. Rutgers - The State Univ., New Brunswick, N. J.); Benczer-Koller, N.; Tape, J.; Guthman, Lewis; Goode, Philip. Phys. Rev. Lett., 23: 594-7(Sept. 15, 1969).

A mean life of 392 ± 12 psec was measured for the 4.49-MeV (5^-) state of ^{40}Ca, corresponding to an E2 transition strength of 1.04 ± 0.03 Weisskopf units which is considerably stronger than that predicted by a one-particle, one-hole description of the states. However, this E2 decay rate and those of eight other E2 transitions between odd-parity states can be understood when the states are described as admixtures of deformed and spherical wave functions. (auth)

Nuclear Properties and Reactions, A ≥ 90

Refer also to abstracts 46257, 46935, 46943, 46967, and 47070.

46977 (AD-686453) HIGH-ENERGY NEUTRON CROSS SECTION VALIDATION AND NEUTRON FLUX SPECTRUM USING THE HENRE SOURCE. Technical Report, November 1965-October 1968. Barrall, Raymond C.; Holmes, John A.; Silbergeld, Mae (Stanford Univ., Calif.). Mar. 1969. Contract AF29(601)-6780. 66p. (AFWL-TR-68-134). CFSTI.

Neutron cross sections reported by various investigators often differ far in excess of the estimates of error reported. The high neutron emission of the High Energy Neutron Reaction Experiment (HENRE) source, 10 to the 13th power n/sec, afforded an opportunity to compare measured values of many disintegration rates in a single experiment thus eliminating some of the uncertainty necessarily associated with such measurements when based on varying standards and normalizations. From these measurements, the 14.6-MeV neutron cross sections of 24 reactions are derived. The neutron spectrum near ground level at 37 feet slant range from the HENRE source was measured by using foil data and SAND II code. (auth) (USGRDR)

46978 (AD-687327) FISSION CHAIN ANALYSIS TABLES FOR ODD MASS VALUES 75 = or < A = or < 155. Alexander, Peter (Isotopes, Inc., Westwood, N. J.). Apr. 1, 1969. Contract DASA01-69-C-0057. 518p. CFSTI.

Established values for the decay linkages, half lives and branching ratios pertinent to a number of odd-A mass chains were employed in a computer calculation. The time varying interdependent population of each member of the mass chain was computed for all odd-A chains with $75 \leq A \leq 155$. Tables containing population values computed at appropriate intervals over the period 0-1.8 years are presented. An initial normalized population of 1.0 is assumed to be distributed to the first member of each of the odd mass chains having $75 \leq A \leq 83$, $107 \leq A \leq 127$ and $145 \leq A \leq 155$. Additional tables are presented for those odd mass chains covering the two peaks of the fission curve ($85 \leq A \leq 105$ and $129 \leq A \leq 143$). Calculations for these mass numbers assume an initial population of 1.0 placed consecutively in each member of the mass chain. Graphical plots of these population interrelationships are also presented. The above results are obtained by solution of the differential equations describing the populations in each mass chain, taking into account all known branching and cross linkages. (auth) (USGRDR)

46979 (AECL-3376) A HIGH RESOLUTION STUDY OF THE ^{239}Pu(d,pf) REACTION. Specht, H. J.; Fraser, J. S.; Milton, J. C. D.; Davies, W. G. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). July 1969. 17p. (CONF-690708-4; SM-122/128). Dep. CFSTI (U. S. Sales Only). CAN $0.50.

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria.

The (d,pf)-reaction on ^{239}Pu has been studied at a bombarding energy of 11.5 MeV using the Chalk River MP Tandem Accelerator. A Brown-Buechner magnetic spectrograph equipped with a 1 m long hyperbolically shaped wire spark chamber detected protons at an angle of 132.5° with respect to the incoming deuteron beam. The energy resolution of the system, which included separation of protons and deuterons by time-of-flight, was ~18 keV fwhm. The angular distribution of fission fragments was measured in coincidence with protons, using an array of 14 wire proportional counters arranged at 10° intervals, with a solid angle increasing monotonically from the classical recoil axis (taken as 0°) to a maximum at 90° without reduction of angular resolution. The overall coincidence resolving time was ~10 ns fwhm. Particular attention was given to the excitation energy region from 4.3 MeV to 5.2 MeV in the residual nucleus where experiments with ~100 keV resolution had shown a peak in the probability ($\sigma_{d,pf}/\sigma_{dp}$) around 5.0 MeV and a weak plateau below the peak. In the present experiment, ~3300 events were accumulated in this region, representing ~210 hours of beam time. Preliminary analysis shows prominent structure in the fission probability consisting of at least seven lines in the peak. The "weak plateau" below the main peak also appears to contain several lines and does not consist of only one narrow line. The fission fragment angular distribution data are consistent with the interpretation that all lines in the region 4.69 to 5.16 MeV have the same angular distribution. The width of the lines in all cases is that of the experimental resolution and their spacing is consistent with present ideas of the level density in the second well. It is unlikely that the fine structure is produced by the mechanism of the (d,p) reaction although it may serve to enhance the structure. (auth)

46980 (ANL-Trans-762) COMPARATIVE MEASUREMENTS OF CHARACTERISTIC K-RADIATION IN THE FISSION OF ^{233}U. Davydov, Yu. P.; Solov'ev, S. M.; Eismont, V. P. Translated for Argonne National Lab., Ill., from Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 718-20(1969). 5p. Dep. CFSTI.

The energy spectra and yields of K x rays from thermal neutron fission of ^{233}U were measured by the relative method. A triple coincidence system of proportional counters was used in comparing the known yields and spectra of K x rays from ^{235}U fission to the yields and spectra of ^{233}U. (J.W.R.)

46981 (CEA-R-3650) THEORETICAL, PHYSICAL, AND EXPERIMENTAL STUDY OF FISSILE AQUEOUS MEDIA. Caizergues, Robert (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires). Apr. 1969. 200p. (In French). Dep.

Thesis. Submitted to Paris Univ., Orsay, France.

A set of theoretical and experimental studies are presented on a) Theoretical calculation methods used for cross sections and the critical parameters; b) Comparison of the theoretical and experimental results: it is shown that the agreement between these results cannot be improved above a certain limit because of the accuracy with which the composition and the dimensions of the media and the microscopic cross sections are known; c) Determination of the ratios η^9/η^5, η^3/η^5 for fissile aqueous media (η: number of neutrons emitted per neutron absorbed, averaged over the reactor neutron spectrum) - evaluation of the accuracy to which these ratios are known; d) Effect of ^{240}Pu: the measurements are carried out on Pu with a ^{240}Pu content of 1.5 per cent, 3.11 per cent and 9.95 per cent; calculation of the resonance integral I_{240} using the experimental results gives values in reasonable agreement with the results obtained by other more conventional methods. e) Measurement of the spectrum indices for aqueous media containing ^{239}Pu, ^{235}U, and ^{233}U. With these latter it is possible to obtain mean fission cross-section rations $\sigma f\ 239/\sigma f\ 235$ for these different spectra. A calculation-experiment comparison is carried out using various theoretical methods. (auth)

46982 (CONF-690518-1) DISINTEGRATION OF ^{104}Rh (43 sec) AND OF ^{104m}Rh (4.4 min). Ionescu, V. A.; Kern, J. (Fribourg Univ. (Switzerland). Physikinstitut). [1968]. 4p. (In French). Dep.

From Meeting of the Swiss Physical Society, Bern, Switzerland.

For even nuclei, the 2-phonon excitation would consist of triplet states 0^+, 2^+, and 4^+, which have been discovered with certainty in only a few nuclei. The β decays of ^{104}Rh (1^+) and its isomeric state 5^+ are particularly favorable to populate the three terms of the triplet. Measurements made on these levels have shown the activity due to the decay of each of the two levels. Six new transitions at 356, 451, 758.78, 777.8, 923.7, and 1793.5 keV were detected. All the gamma rays observed are placed in a decay scheme given. The observation of a weak but nevertheless certain transition at 1792 keV is in contradiction with the assignment of a spin and parity 0^+ for the level that it depopulates. The transition of 778 keV is probably a new level of spin 0 which is the third term of the triplet sought. (J.S.R.)

46983 (INR-1002) INTERNAL BREMSSTRAHLUNG ACCOMPANYING THE ELECTRON CAPTURE DECAY OF ^{145}Sm. Sujkowski, Z.; Mysiek, B.; Zglinski, A.; Adamowicz, B. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 8p. Dep. CFSTI (U. S. Sales Only).

The internal bremsstrahlung IB effect in the decay of ^{145}Sm first forbidden, non-unique is studied. Singles photon scintillation spectra are measured as well as the spectra in coincidence with the x-rays and the conversion electrons of the 61-keV gamma transition. The IB spectra due to the K capture and L + M + ... capture are analyzed separately. It is suggested that the shape of the L + M + ... IB spectrum differs from the theoretical one for allowed electron capture transition. Partial probabilities for the radiative K- and L + M + ... - radiative capture relative to that of the ordinary K capture are determined. The total decay energy Q, is deduced to be Q = 607 ± 10 keV. (auth)

46984 (INR-1010) EMISSION OF LIGHT NUCLEI IN THERMAL NEUTRON FISSION OF ^{239}Pu. Krogulski, T.; Chwaszczewska, J.; Dakowski, M.; Piasecki, E.; Sowinski, M.; Tys, J. (Institute of Nuclear Research, Warsaw (Poland)). 1968. 10p. Dep. CFSTI (U. S. Sales Only).

The relative intensities and energy spectra of ^{1}H, ^{2}H, ^{3}H, ^{4}He, ^{6}He, and ^{8}He particles from the thermal neutron fission of ^{239}Pu have been measured. The comparison with the data relative to the spontaneous fission of ^{252}Cf and the thermal neutron fission of ^{235}U reveals a prominent similarity of the tripartition process irrespective of the fissioning nucleus. (auth)

46985 (JAERI-1178) COLLECTED PAPERS ON DISINTEGRATION STUDIES OF SHORT-LIVED NUCLIDES. Ishimori, Tomitaro; Ueno, Kaoru (eds.) (Japan Atomic Energy Research Inst., [Tokyo]). Apr. 1969. 28p. Dep. CFSTI (U. S. Sales Only).

Accurate values for the half-life of ^{49}Ca, ^{49}Sc, ^{51}Ti, ^{92m}Nb, ^{97m}Nb, ^{98}Nb, ^{103m}Rh, ^{105}Rh, ^{106}Rh, ^{137m}Ba, and ^{234m}Pa were determined after radiochemical purification. (auth)

46986 (JUL-574-FN) DETERMINATION OF THE PRIMARY NUCLEAR CHARGE OF FISSION PRODUCTS FROM THE THERMAL FISSION OF ^{235}U BY MEASUREMENT OF THE β CHAIN LENGTH. Sistemich, K. (Kernforschungsanlage, Juelich (West Germany). Institut fuer Festkoerper- und Neutronenphysik). Feb. 1969. 116p. (In German). Dep.

Thesis. Submitted to Technische Hochschule, Aachen, Ger.

The mean primary nuclear charge of fission products from the thermal fission of ^{235}U was determined by the measurement of the β chain length of the mass-separated fission products. The β chain length measurement was made with a 4π detector of plastic scintillator material. The falsification of the measurement by conversion electrons and γ quanta, which were emitted in the β decays, were avoided by the 4π geometry of the detector. The mass separation of the fission products was made with a gas-filled mass separator. The separator has at high fission product intensity a moderate mass resolution so that a mixture of several masses was obtained at the focus. The primary nuclear charges determined were the mean values of all nuclear charges occurring in the mass mixture. The measurement extended for light nuclei over the mass range $86 < A < 104$ and for heavy nuclei over the range $137 < A < 143$. There was a linear dependence of the mean primary nuclear charge on the fission product mass. The deviation of the measured primary charge from the nuclear charge which was obtained in a distribution of the protons to the two fission products proportional to mass, was on the average +0.4 charge units for light nuclei and −0.4 for heavy nuclei. A mean value was determined for the width of the distribution of the primary nuclear charge with which fission products form a secondary mass. The standard deviation of this distribution averaged over all fission product masses was $\bar{\sigma} = 0.59 \pm 0.03$ charge units. (tr-auth)

46987 (MLM-1534) IDENTIFICATION OF THE 871-keV PHOTON OBSERVED FROM ^{238}Pu SOURCES. Tomlinson, F. K. (Mound Lab., Miamisburg, Ohio). July 31, 1969. Contract AT(33-1)-Gen-53. 18p. Dep. CFSTI.

The origin of the 871-keV photon which appears in many gamma-ray spectra of plutonium-238 was experimentally determined. Gamma-ray spectra were taken with a plutonium-238 source contained in various gaseous environments. The 871-keV photon was observed only when the source was in an atmosphere which contained nitrogen, indicating that the 871-keV photon originated from the decay of the first excited state of the residual nucleus in the $^{14}N(\alpha,p)^{17}O$ reaction. Protons from this reaction were investigated and found to be present. The intensity of the 871-keV radiation was found to be 4.83 times that of the 767-keV photon in plutonium-238 when the plutonium-238 material was exposed to air. (auth)

46988 (NP-17967) LEVEL SCHEMES OF SOME ODD-Z NUCLEI DECAYING BY ALPHA EMISSION. Leang, Chin-fan (Paris Univ., Orsay (France). Faculte des Sciences). 1969. 95p. (In French). Dep.

Thesis.

The level scheme of the elements ^{219}Fr, ^{220}Fr, ^{221}Fr, ^{217}At, ^{213}Bi, and ^{227}Ac, formed by the α emission of ^{223}Ac, ^{224}Ac, ^{225}Ac, ^{221}Fr, ^{217}At, and ^{231}Pa, was studied with different measurement methods. These elements are located, for the most part, in the region between spherical nuclei and greatly deformed nuclei. The theoretical models which describe these two categories are inexact for the nuclei of Fr and At. The construction of level schemes for these elements, therefore, is based only on experimental results. The studies began with α magnetic spectrography. Because of rapid methods of preparation of sources, the α magnetic spectra of the short-lived isotopes ^{221}Fr and ^{223}Ac were obtained for the first time. The placement of γ transitions was determined by the method of α-γ bidimensional coincidences. In the case ^{223}Ac → ^{221}Fr, the natures of the low energy transitions were determined from a study of the conversion spectrum. In other cases, the multipolarities of the transitions were deduced either from the X/γ ratio or from intensity balances. Proposed level schemes were given for ^{221}Fr, ^{217}At, ^{213}Bi, ^{220}Fr, ^{219}Fr, and ^{227}Ac. (J.S.R.)

46989 (RLO-1388-97) SPONTANEOUS FISSION ISOMERS WITH VERY SHORT HALF-LIVES. Vandenbosch, R.; Wolf, K. L. (Washington Univ., Seattle). May 26, 1969. 14p. (SM-122/110; CONF-690708-2). Dep. CFSTI.

From 2nd Conference on Physics and Chemistry of Fission, Vienna, Austria.

The results of various reactions studied which relate to the various plutonium isomers characterized or search for, including ^{240}Pu, ^{239}Pu, ^{238}Pu, ^{237}Pu, and ^{236}Pu, are presented. The method employed is a direct electronic measurement of the time between the arrival of a burst of particles at the target and the time of fission decay of the isomeric state. (B.G.D.)

46990 (UCRL-71830) DETECTION OF A DIRECT PHOTONEUTRON REACTION IN ^{208}Pb NEAR 7 MeV. Bowman, C. D.; Baglan, R. J.; Berman, B. L. (California Univ., Livermore. Lawrence Radiation Lab.). June 27, 1969. 8p. (CONF-690816-4). Dep. CFSTI.

From Gordon Conference for Photonuclear Reactions, Tilton, N. H.

A threshold photoneutron experiment on ^{208}Pb at 7 MeV is described. The cross section vs neutron energy data obtained at an angle of 135° with the photon beam on separated isotopes of Pb so that all the peaks could be assigned to the proper isotopes were examined. It is shown that the value predicted for the lower limit of the direct cross section is larger than that predicted by the Lane and Lynn inverse reaction model (Nuc. Phys. 17: 563 (1960)) and (Nuc. Phys. 17: 586 (1960)) which proposes a direct capture mechanism in which an incoming neutron in an s-wave single particle orbit falls directly into a bound p-wave orbit, bypassing the formation of the compound nucleus and emitting a single gamma ray. It is also shown that the ^{208}Pb giant dipole resonance decays by neutron emission to the ground state of ^{207}Pb. (B.G.D.)

46991 INELASTIC NEUTRON SCATTERING AND GAMMA PRODUCTION FROM FAST-NEUTRON BOMBARDMENT OF ^{235}U. Drake, Darrell M. (Los Alamos Scientific Lab., N. Mex.). Nucl. Phys., A133: 108-12(1969).

Cross sections for gamma production by 4.0, 6.0 and 7.5 MeV neutron interactions with ^{235}U have been measured. Inelastic neutron scattering cross sections deduced from the gamma-ray data are 2.13 ± 0.50, 2.02 ± 0.36 and 0.77 ± 0.32 b for 4.0, 6.0 and 7.5 MeV. (auth)

46992 ANGULAR DISTRIBUTIONS FOR THE ^{156}Gd(d,t)^{155}Gd REACTION. Jaskola, M. (Inst. for Nuclear Research, Warsaw); Tjoem, P. O.; Elbek, B. Nucl. Phys., A133: 65-76(1969).

The angular distributions for triton groups from the ^{156}Gd(d,t) reaction have been measured at a deuteron energy of 12.1 MeV. The distributions were compared with similar distributions for the ^{160}Gd(d,t) reaction which had been measured earlier. On this basis, it was possible to establish or confirm the Nilsson assignments for a number of levels in the ^{155}Gd nucleus. Special attention was paid to the energy levels at 87 keV (l = 2), 105 keV (doublet l = 2 and l = 4), 119 keV (l = 5) and 214 keV (l = 6) and their relations to the Nilsson model. It is discussed how the strong Coriolis coupling of even parity bands can account for the observed energy levels and neutron transfer cross sections. (auth)

46993 THE 1/2$^-$[541] ROTATIONAL BAND IN ^{175}Lu AND THE Q-VALUE OF THE ELECTRON-CAPTURE DECAY. Johansen, K. H.; Bengtson, B.; Hansen, P. G.; Hornshoej, P. (Univ. of Aarhus, Denmark). Nucl. Phys., A133: 213-21(1969).

A re-investigation of the ^{175}Hf decay scheme by means of Ge(Li) counters, a six-gap magnetic beta-ray spectrometer and coincidence techniques establishes a family of odd-parity levels characterized by the following energies (in keV) and spins and parities: 353.6 ($\frac{5}{2}^-$), 358.2 (tentative, $\frac{1}{2}^-$) and 514.9($\frac{3}{2}^-$). The existence of a level at 504.7 keV has been disproved. These levels are interpreted as belonging to the Nilsson configuration $\frac{1}{2}^-$[541]. For three levels in ^{175}Lu, the K-capture probability P_K was determined by electron-KX coincidences; for the 514.9 keV level, we find $P_K = 0.49 \pm 0.12$ corresponding to a Q-value of 618 keV. (auth)

46994 STUDY OF THE ^{236}U(^{3}He,α)^{235}U REACTION. Elze, Th. W.; Huizenga, J. R. (Univ. of Rochester, N. Y.). Nucl. Phys., A133: 10-22(1969).

The ^{236}U(^{3}He,α)^{235}U reaction has been studied with a 30 MeV ^{3}He beam. Based on a comparison of both the measured and calculated spectroscopic factors and the experimental and theoretical (DWBA) angular distributions of the emitted alpha particles, levels which are members of the following Nilsson bands are assigned in ^{235}U: $\frac{1}{2}$[743↑], $\frac{1}{2}$[631↓], $\frac{5}{2}$[622↑], $\frac{5}{2}$[633↓], $\frac{3}{2}$[631↑] and $\frac{5}{2}$[752↑]. Additional states are tentatively assigned as members of the $\frac{3}{2}$[761↑] and $\frac{3}{2}$[642↓] bands. Theoretical spectroscopic factors computed with harmonic oscillator and Woods-Saxon nuclear potentials are in good agreement with each other as well as with the experimental values. (auth)

46995 ALPHA-DECAY HALF-LIFE OF ^{151}Tb. Toth, K. S. (Oak Ridge National Lab., Tenn.). Nucl. Phys., A133: 222-4 (1969).

The decay of ^{151}Tb was studied to resolve between conflicting values that have been measured for the alpha-decay half-life of ^{151}Tb. By determining the alpha-decay and total decay rates of a chemically purified sample that contained mainly ^{151}Tb activity,

an α/total branching ratio of $(8.3 \pm 2.5) \times 10^{-5}$ was calculated. This ratio corresponds to an alpha half-life of 25 ± 7 y. The indication then is that the alpha decay rate of ^{151}Tb, in comparison to the decay rates of neighboring doubly even alpha emitters, is hindered by a factor of about 4.5 and not $\gtrsim$100 as has been reported by some investigators. (auth)

46996 NEW ISOMER ^{108}Rh($T_{1/2}$ = 6 min). Pinston, J. A.; Schussler, F.; Moussa, A. (Centre d'Etudes Nucleaires, Grenoble, France). Nucl. Phys., A133: 124-34(1969). (In French).

Study of beta and gamma activities produced by the (n,p) reaction on natural Pd has shown a new ^{108}Rh isomer of 6 min half-life. Three new levels at 1336, 2283, 2864 keV are attributed to ^{108}Pd. The decay energy of this new isomer is estimated to be 4430 keV. (auth)

46997 FOUR-PARTICLE $(1g_{9/2})^3(2p_{1/2})^1$ TYPE PROTON STATES. Peker, L. K. (All Union Scientific Research Inst. for Metrology, Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 661-4(Apr. 1969). (In Russian).

Study of the multiparticle levels of nuclei controlled by the residual interactions of several nucleons is an important source of our knowledge concerning such interactions. Therefore, some properties of the four-particle levels of even-even spheric nuclei were examined, considering the multiplets of $p_1p_2p_3p_4$ four-particle configurations in ^{92}Mo and ^{94}Ru nuclei with a filled neutron shell (N = 50). The calculations, which agreed with experimental data on levels of bands with negative parity in ^{92}Mo, indicated that all levels involved four particles and belonged to the $(1g_{9/2})^3(2p_{1/2})^1$ multiplet configuration. A similar band probably exists in the ^{94}Ru nucleus. In ^{90}Zr, where the four-proton configuration is not possible without disturbing the Z = 38 field shell, the multiplet with $I^\pi = 11^-$, 9^-, 7^- may be expected to have a much higher energy. Actually up to now, only 2 $I^\pi = 5^-$ and 4^- were found; they belonged to the two-particle doublet $(1g_{9/2})^1(p_{1/2})^1$ and the $I^\pi = 7^-$, 9^- levels were not observed. (TTT)

46998 NEW STUDY OF THE DECAY OF ^{181}Hf. Klyucharev, V. A.; Rakivnenko, Yu. N.; Bozhko, V. P.; Skakun, E. A.; Golovchenko, Yu. V.; Romanii, I. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 714-17(Apr. 1969). (In Russian).

The level scheme of ^{181}Hf, developed on the basis of available experimental data does not contain levels of energies higher than 618.9 keV. Experiments were carried out to observe transitions from the levels of ^{181}Ta lying above 118.9 keV by studying $\gamma\gamma$ coincidences in the conversion electron spectrum. Metallic, 97% enriched ^{180}Hf was prepared from $^{180}HfO_2$ to be used as source material by the decomposition of the hafnium iodide; this material was activated by slow neutrons. For the study of conversion spectra the activated hafnium was dissolved and the H_2SO_4 solution was applied to an aluminum foil and dried. The experimental results obtained by means of a high-speed β spectrometer, time-amplitude converter and a Ge(Li) detector, indicated that during the decay of ^{181}Hf, the levels of ^{181}Ta with energies above 118.9 keV are not populated. The decay scheme proposed by A. H. Muir et al., is considered correct. (TTT)

46999 ANALYSIS OF THE ^{241}Am(n,γ)^{242mf}Am REACTION. Yungklaussen, Kh.; Pleve, A. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 695-9(Apr. 1969). (In Russian).

The spontaneously fissioning ^{242mf}Am nucleus was recently prepared by the radiative capture reaction of fast neutrons of the ^{241}Am nucleus. An unusual correlation was found to exist between the cross section and the energy. It was assumed that the problem involves form isomerism, described by G. N. Flerov et al., i.e., the ground and isomeric states of the nucleus have different deformation and therefore γ transitions between them are strongly slowed down. The authors earlier study of the ^{242}Pu(d, 2n)^{242}Am reaction was further developed in order to explain the existence of the maximum of the excitation curve $\sigma_m(E_n)$, taking into account only the one-dimensional dependence of the potential energy on the deformation U_β. Analysis of the nature of the isomer and the reaction mechanism indicated agreement between the theoretically expected and experimentally found form of the excitation energy. Further experiments are needed to obtain definite proof. (TTT)

47000 COMPARATIVE MEASUREMENT OF THE CHARACTERISTIC K RADIATION DURING THE FISSION OF ^{233}U. Davydov, Yu. P.; Solov'ev, S. M.; Eismont, V. P. (Radium Inst., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 718-20(Apr. 1969). (In Russian).

The energy spectra and the K-radiation yields during the fission of ^{233}U by thermal neutrons were measured in order to clarify the emission process and the nuclear charge distribution of fragments. The method used involved comparison with known yields and spectra of K radiation observed during the fission of ^{235}U. The ^{233}U and ^{235}U targets, with a thickness of 100 and 300 μg, respectively, were prepared by the vaporization of UF_4 on an aluminum support which is transparent for the fragments. They were placed crosswise at the common cathode of a dual proportional counter located in the neutron beam; the x radiation generated by the fission was recorded by another counter. The triple coincidence method selected only simultaneous generation of pulses within the limits of $2\tau = 0.7$ μsec generated in the 2 halves of the fragment counter and in an x-ray quantum counter. Measurement of the mean energy of K radiation of light and heavy fragments reflects the changes in the mean, prompt charges. It was found that in case of ^{233}U, the quantum energy of the light fragment was 0.3 ± 0.1 keV less and that of the heavier fragments was 0.2 ± 1 keV more than for ^{235}U. This difference was attributed to differences in the charge. (TTT)

47001 FISSION OF ^{233}U IN THE (d,pf) REACTION AT VARIOUS DEUTERON ENERGIES. Andreev, M. F.; Serov, V. I.; Zavgorodnii, V. A.; Pereshivkin, V. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 726-9(Apr. 1969). (In Russian).

The (d,pf) reactions are of special interest for the study of fission thresholds and probability. In order to clarify the dependence of the various characteristics of fission on the energy of the emitted particles, the ^{233}U(d,pf) reaction was investigated at deuteron energies from 8.0 to 9.5 MeV, using a supercharging electrostatic generator. The accelerated deuteron beam was directed onto the ^{233}U oxide target on a gold foil. The beam current was measured with an integrator on a Faraday cylinder placed behind the target; the $\sim 3 \times 10^{-9}$ α deuteron beam intensity was determined from the elastically scattered deuteron charge. The emitted protons were recorded by silicon semiconductor counters at 130° with respect to the direction of the deuteron beam. The proton spectra which yielded coincidences with fission, were measured at deuteron energies of 8 to 9.5 MeV. They indicated that the direct processes play a predominant part in the (d,pf) reaction. Interaction of deuterons with nuclei were found to be only of peripheral interest. Random coincidences at 8.5 MeV deuteron energy level amounted to only 0.5% of the true ones. The amplitude of fission probability and the neutron threshold energy were calculated in the center-of-mass system from the data obtained. (TTT)

47002 FINE STRUCTURE OF ENERGY SPECTRA OF FRAGMENTS RESULTING FROM THE FISSION OF ^{235}U BY THERMAL NEUTRONS. Baranov, I. A.; Protopopov, A. N.; Shiryaev, B. M. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 741-2 (Apr. 1969). (In Russian).

A semiempirical mass formula was derived to indicate the correlation between the yields and the maximum excitation of fission products to obtain more precise values. Measurements were carried out with a surface-barrier silicon semiconductor counter, determining the energy spectra of the heavy fragments for various energies of the light fragment resulting from the fission of ^{235}U by thermal neutrons. The results revealed that the parameters derived from the statistical theory did not allow reproducibility of experimental results. (TTT)

47003 NATURE OF THE LOWER EXCITED STATES OF ^{151}Pm. Voinova, N. A.; Egorov, A. I.; Kalinichev, Yu. V.; Sergeev, A. G. (Inst. of Technical Physics, Moscow). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 626-34(Apr. 1969). (In Russian).

A previous study on the level scheme of ^{151}Pm indicated that the lower excitation levels of this nucleus may be interpreted within the framework of the general model of the nucleus; however, additional data are required for further confirmation, especially about the multipole nature of the transitions. Therefore, the multipole characteristics of the 11 strongest low-energy transitions of ^{151}Pm were determined by measuring the internal conversion coefficients. This involved a simultaneous measurement of the γ spectrum and of the conversion electrons by means of Ge(Li) and Si(Li) detectors. The source material ^{151}Nd was prepared by the (n,γ) reaction. The new data on the intensity and multipole characteristics of the soft γ transitions and the newly discovered γ transitions confirmed the previously proposed interpretation of the excited levels of ^{151}Pm; they indicate that the ^{151}Pm nucleus is strongly deformed. (TTT)

47004 CONVERSION ELECTRONS OF ^{160}Ho AND THE LEVELS OF ^{160}Dy. Grigor'ev, E. P.; Gromov, K. Ya.; Zhelev, Zh. T.; Islamov, T. A.; Kalinnikov, V. G.; Nazarov, U. K.; Sabirov, S. S. (Joint Inst. for Nuclear Research, Dubna, USSR. Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 635-48(Apr. 1969). (In Russian).

A doubly-focusing spectrometer was used for studying the internal conversion electron spectrum of ^{160}Ho; the measurements were made at electron energies from 1 to 3.1 MeV with an error

of 0.05%. The chromatographically separated erbium fraction of the fast-proton irradiation products of tantalum was used as source material; the ^{160}Er ($T_{½}$ = 28.6 hours) was in equilibrium with its daughters ^{160*}Ho ($T_{½}$ = 5 hours) and ^{160}Ho ($T_{½}$ = 25 minutes). The conversion lines observed in the study corresponded to about 60 new transitions. The data allowed determination of the decay scheme of ^{160}Ho; some of the γ transitions differed from earlier findings. The new data were also used to determine several new excited levels of ^{160}Dy; the criterion applied was the coincidence of the sums of energies of the various cascade transitions and observation of energy gaps in the rotational bands. It was found that Chu and Pemen's semiempirical method of calculation yields data which agreed with the values obtained by more exact computations. (TTT)

47005 PHOTONEUTRON CROSS SECTIONS FOR ^{90}Zr AND ^{91}Zr. Antropov, G. P.; Mitrofanov, I. E.; Prokof'ev, A. I.; Russkikh, V. S. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 700-3(Apr. 1969). (In Russian).

The photonuclear reactions involving nuclei with filled neutron shell N = 50 are not well known, therefore, the cross sections of the (γ,n) reaction were measured for the ^{90}Zr and ^{91}Zr isotopes. The zirconium oxide targets used contained 96.6% and 63.6% of ^{90}Zr and ^{91}Zr respectively. Using the author's previously described method for the measurements which were carried out in the bremsstrahlung of the betatron with a maximum electron energy of 30 MeV. The "jump" stabilization scheme used made it possible to measure the reaction yield curve simultaneously throughout the whole energy range. The curves indicated a splitting of the giant resonance maximum; this was especially strong for ^{91}Zr. The Danos-Okamoto hydrodynamic model could be applied to the experimental results. It was found possible to calculate the specific quadrupole moments of this nucleus in the hydrodynamic approximation. The specific quadrupole moments of ^{90}Zr and ^{91}Zr were Q = −0.7 and 1.1 barn; as expected, addition of one nucleon to the superfilled shell increases the value of Q_0. (TTT)

47006 QUADRUPOLE AND OCTUPOLE EXCITATIONS OF THE EVEN TIN ISOTOPES BY ELECTRON SCATTERING. Curtis, Thomas Hasbrook. New Haven, Yale Univ., 1968. 151p.

Thesis.

Form factors as a function of momentum transfer, q, obtained by the inelastic scattering of 60-MeV electrons from the first 2^+ and 3^- collective states of ^{116}Sn, ^{118}Sn and ^{120}Sn are reported. Reduced transition probabilities, B(EL) and transition radii, R^2_M, are extracted from the data, using a transition charge distribution with a radial dependence given by the derivative of a Fermi charge distribution. The values are compared to previous experimental determinations. Various nuclear models used to calculate B(EL) are briefly described and their predictions compared with the results. In addition, the parameters c and t for a ground-state Fermi charge distribution, obtained by elastic scattering, are reported for ^{116}Sn, ^{118}Sn, and ^{120}Sn and ^{124}Sn. (Diss. Abstr.)

47007 STUDY OF THE (t,p) REACTION ON $^{90\ 92\ 94\ 96}$Zr AND $^{122\ 124}$Sn. Beery, Jerome Griggs. Albuquerque, N. Mex., Univ. of New Mexico, 1969. 119p.

Thesis.

A study was made of the (t,p) reaction on targets of ^{90,92,94,96}Zr and ^{122,124}Sn. The purpose was to investigate the nuclear energy levels that are populated by putting two neutrons into a target nucleus. The targets were bombarded with 20-MeV tritons from the tandem Van de Graaff facility. Protons were detected with a solid-state counter telescope and the data was recorded with an on-line digital computer. Energy spectra were taken for each of the targets utilizing a magnetic spectrometer in order to obtain excitation energies with an accuracy of ±10 keV. The zirconium data was analyzed with a distorted wave Born-approximation calculation and relative spectroscopic strengths were obtained. The energy level positions and strengths are compared to a nuclear structure calculation. (Diss. Abstr.)

47008 ISOMERISM IN ^{129}La: EVIDENCE FOR OBLATE NUCLEAR SHAPE. Alexander, K. F.; Neubert, W.; Rotter, H.; Chojnacki, S.; Droste, Ch.; Morek, T. (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., A133: 77-88(1969).

Using the reactions ^{121}Sb + ^{12}C, ^{116,118,120}Sn + ^{14}N, ^{115}In + ^{18}O a new activity with $T_{½}$ = 0.56 ± 0.05 sec was produced. It was identified as an isomeric state of ^{129}La by analysis of excitation functions and cross bombardments. The isomeric state decays by a 104 keV (E3) −67.5 keV (M1) cascade to the ground state. The experimental data confirm recent calculations which predict for ^{129}La an oblate equilibrium deformation. (auth)

47009 THE M4 TRANSITIONS IN ^{131}Xe AND ^{133}Xe. Fransson, Kjell; Erman, Peter. (Research Inst. for Physics, Stockholm). Ark. Fys., 39: 7-14(1969).

The L subshell conversion ratios of the isomeric transitions in ^{131}Xe (163.96 keV) and ^{133}Xe (232.8 keV) were measured with high resolution in a double focusing beta-spectrometer using high luminosity techniques. From a comparison of these ratios to the corresponding theoretical ratios calculated by Sliv and Band and by Rose, it follows that both transitions are of M4 type and does not contain any E5 admixture larger than 2 percent. Some details of the decay of ^{133}Xe were also studied. (auth) (Sweden)

47010 EVALUATION OF THE ACTIVATION CROSS SECTION OF ^{151}Eu. Orestano, F. V.; Pistella, F. (CNEN, Rome). Nucl. Sci. Eng., 37: 478-80(Sept. 1969).

The neutron resonance parameters and the activation cross section for ^{151}Eu in the thermal energy range were evaluated. The contribution of the negative energy resonance was calculated using the Breit–Wigner formula. (J.W.R.)

47011 TRANSURANIUMS. Ouvry, Francoise; Martinot, Michel. Nucleus (Paris), 10: No. 1, 23-8(1969). (In French).

The discovery, stability, and synthesis of the transuranium elements are briefly described. The use of these elements as neutron sources and as energy sources is discussed. (J.S.R.)

47012 NUCLEAR CHARGE DISPERSION IN THE FISSION OF ^{235}U AND ^{238}U WITH 20 TO 85 MeV PROTONS. Khan, Amir Hussain. Montreal, McGill Univ., 1968.

Thesis.

The independent formation cross sections of ^{68}Ga, ^{70}Ga, ^{72}Ga, ^{90}Y, ^{91}Y, ^{92}Y and the cumulative cross sections of ^{73}Ga, ^{72}Zn, ^{91}Sr, ^{92}Sr, and ^{93}Y produced in the fission of ^{238}U induced by 20 to 85-MeV protons were measured radio-chemically. The cross sections of yttrium and strontium nuclides formed in the proton-induced fission of ^{225}U were also measured in the same energy range. The excitation functions of all the nuclides show the expected shapes and magnitudes. The charge dispersion curves drawn from the cross sections of yttrium and strontium show similar features in both ^{238}U and ^{235}U fission. The curves become broader with increasing energy. The most probable charge, Z_p, increases up to 50 MeV and then remains almost constant. These phenomena are qualitatively accounted for in terms of nucleon evaporation prior to fission leading to a distribution of fissioning nuclei or nucleon evaporation from the primary fragments. The isomer ratios of ^{90}Y and ^{91}Y were measured for both ^{235}U and ^{238}U fission. An approximate calculation has yielded a value of 2-3ħ units for the average angular momentum of the primary fragments to account for the observed isomer ratios. (Dissert. Abstr.)

47013 NEUTRON RESONANCES OF THE RARE Gd ISOTOPES. Vertebnyi, V. P.; Kal'chenko, A. I.; Pasechnik, M. V.; Pisanko, Zh. I.; Rudyshin, V. K. (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 14: 520-3(Mar. 1969). (In Russian).

Neutron transmissions by a time-of-flight method were measured on ^{152}Gd, ^{154}Gd and natural gadolinium oxide targets at neutron energies of 0.7 to 3 eV (resolution of 0.2 microsec/m) and 3 to 1000 eV (resolution of 0.05 microsec/m). Triple-slotted quartz containers having slit dimensions 20 × 1.5 × 4 mm were used for the measurements. The ratio of the transmission of the enriched ^{152}Gd sample to the transmission of the natural Gd sample showed the ^{152}Gd resonances in the form of valleys on a plot of the data. The ^{157}Gd resonances, and the resonances of the even isotopes showed up in the form of peaks, since the concentration of these isotopes were greater in the natural sample. The distances between levels of the separate isotopes are tabulated. (TTT)

47014 THE DECAY OF ^{208}Tl. GAMMA-RAY MEASUREMENT. Larsen, Jens S.; Joergensen, Bent C. (Univ. of Copenhagen). Z. Phys., 227: 65-70(1969).

The gamma rays following the decay of ^{208}Tl were studied using a separated ^{208}Tl-source and a Ge(Li)-detector. A decay scheme is proposed, with levels in ^{208}Pb at 3,920, 4,126, and 4,180 keV in addition to previously well-established levels. No support was found for β-branching to levels above 4.2 MeV. (auth)

47015 GROSS STRUCTURE IN EXCITATION FUNCTIONS FOR ^{207}Pb(p,p')^{207}Pb IN THE REGION OF OVERLAPPING ISOBARIC ANALOGUE RESONANCES. Heusler, A.; Endriss, M.; Moore, C. Fred; Grosse, E.; v. Brentano, P. (Max-Planck-Institut fuer Kernphysik, Heidelberg). Z. Phys., 227: 55-64(1969).

Prominent resonances in the reaction ^{207}Pb(p,p')^{207}Pb leading to the low-lying states in ^{207}Pb($\frac{1}{2}^-$ g.s., $\frac{5}{2}^-$ 0.57 MeV, $\frac{3}{2}^-$ 0.89 MeV, $\frac{1}{2}^-$ 2.33 MeV) are observed between E_p = 16 and 18 MeV. The structures in the excitation functions are interpreted as being due to analog states in ^{208}Pb which are mixtures of neutron particle-hole configurations. (auth)

47016 THE DECAYS OF ^{122}Xe ($T_{1/2}$ = 20.1 h) AND ^{122}I($T_{1/2}$ = 3.6 min). Gfoeller, D.; Langhoff, H.; Smend, F.; Weirauch, W.; Schmidt-Ott, W.-D. (Univ., Goettingen, Ger.). Z. Phys., 227: 45-54(1969). (In German).

The γ spectra emitted in the decay of ^{122}Xe and ^{122}I were investigated using Ge(Li) detectors and a Ge(Li)-NaI coincidence apparatus. Fourteen γ transitions with energies between 61.8 and 416.9 keV were identified in the decay of ^{122}Xe, 44 transitions between 564.0 and 3,291.0 keV in the decay of ^{122}I. Level schemes having 7 excited levels for ^{122}I and 21 excited levels for ^{122}Te are proposed. (auth)

47017 ANGULAR CORRELATIONS BETWEEN NEUTRONS FROM (n,2n) REACTIONS ON LEAD AND BISMUTH. Prokopets, G. A.; Strizhak, V. I.; Voitenko, V. A. (Kiev State Univ.). Ukr. Fiz. Zh., 14: 865-7(May 1969). (In Russian).

A collimated beam of 14-MeV neutrons, produced by bombarding a rotating tritium target with 200-keV deuterons, was allowed to strike the lead or bismuth target (a hollow sphere 9 cm in diameter with walls 2 cm thick) at a distance 60 cm from the exit opening of the collimator. The neutrons were counted by two scintillation detectors with neutron-gamma coincidence counting and a resolving time of 10^{-7} sec. The detectors were placed at different distances from the scattering sample (35 and 80 cm) in order to decrease the effect of scattering from counter to counter. The differential cross-sections are plotted as a function of the angle. A pronounced anisotropy was observed at an angle of 65°. The angular distributions were identical for Pb and Bi. These results indicate that direct processes may play a significant part in (n,2n) reactions. (TTT)

47018 HALF-LIFE MEASUREMENTS AND GAMMA SPECTROSCOPY IN THE DECAY ^{184m}Re → ^{184}W. Glatz, J. (Univ., Freiburg i. B. Technical Univ., Munich); Loebner, K. E. G.; Oppermann, F. Z. Phys., 227: 83-98(1969).

The half-lives of the intrinsic states at 1,285.8 and 1,502.2 keV in ^{184}W were measured in the decay of ^{184m}Re to be 8.33 ± 0.18 μs and 2.35 ± 0.10 ns, respectively. These half-lives determine absolute gamma-ray transition probabilities of eight transitions and yield upper limits for three transitions. The decay scheme of ^{184m}Re → ^{184}W is improved through measurements of delayed gamma-ray spectra with a Ge(Li) detector. Spin and Nilsson model interpretations are discussed. (auth)

47019 STUDY OF ^{106*}Rh AND OF THE LEVELS OF ^{106}Pd. Anton'eva, N. M.; Grigor'ev, E. P.; Protasova, L. F. (Leningrad State Univ.). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 649-57(Apr. 1969). (In Russian).

The levels of ^{106}Pd may be excited by the decay of 2 isomers of ^{106}Rh, 2 isomers of ^{106}Ag, and nuclear reactions. The γ spectrum of the ^{106*}Rh was investigated with semiconductor spectrometers, in order to establish which of the levels of ^{106}Pd is populated by the β decay of this isomer. The ^{106*}Rh specimens were prepared by irradiating a Cd target in the internal beam of synchrocyclotron at a proton energy of 660 MeV; the rhodium fraction was separated out from the radiation products by partition chromatography. Only the γ transitions known from the decay of ^{106*}Ag were observed. In view of the fact that the ^{106*}Rh and ^{106*}Ag isomeric levels have a particle-hole structure, the spin of the lower level of the corresponding multiplet in the odd-odd nucleus should be $J = j_p + j_n - 1 = 6$; this was indeed experimentally observed. The distribution of the components of the multiplet $[n(g\ 7/2)^1 n(d\ 5/2)^{-1}]$ in ^{106}Pd is not known. The intensity of the population of levels with various spins in the (n,γ) reaction was studied; direct transitions from the capture state have a low intensity of only 0.1% of the number of neutron captures. States below the 2 MeV level were found strongly populated; the intensity between 2 and 3 MeV was of the order of 1%. (TTT)

47020 BOUNDS FOR STABILITY REGION OF SUPERHEAVY NUCLEI. Muzychka, Yu. A. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 113-14(July 1969). (In Russian).

Fission barriers for heavy nuclei were calculated aiming to establish the bounds for stability of superheavy nuclei. Bounds of the region where nuclei have the fission barrier more than 5 MeV, are determined. (auth)

47021 PRODUCTION OF SPONTANEOUSLY FISSIBLE ISOMER ^{243}Am AT THERMAL NEUTRON CAPTURE. Gangrskii, Yu. P.; Gavrilov, K. A.; Markov, B. N.; Nguyen Kong Khan; Polikanov, S. M. (Joint Inst. for Nuclear Research, Dubna, USSR). Yadern. Fiz., 10: 65-9(July 1969). (In Russian).

The cross section of production of the spontaneously fissible isomer ^{243}Am in thermal neutron capture by ^{241}Am is measured to be (1.0 ± 0.5) · 10^{-28} cm^2. The impulse beam of thermal neutrons was obtained by exposition of a lead block to 660-MeV protons and by moderating the produced neutrons in water. The fission fragments were detected by a spark counter. A correlation is found between the induced fission cross section for ^{241}Am and the cross section of production of spontaneously fissible isomer ^{242}Am. The correlation is discussed on the basis of the hypothesis of the shape isomery. (auth)

47022 MASS- AND ENERGY-DISTRIBUTIONS OF FRAGMENTS AT PHOTOFISSION OF ^{238}U, ^{209}Bi, AND ^{197}Au NUCLEI. Komar, A. P.; Bochagov, B. A.; Kotov, A. A.; Ranyuk, Yu. N.; Semenchuk, G. G.; Solyakin, G. E.; Sorokin, P. V. (Ioffe Inst. of Physics and Tech., Leningrad. Physical-Technical Inst., Kharkov). Yadern. Fiz., 10: 51-60(July 1969). (In Russian).

Mass and energy distributions of pair fragments of photofission of ^{238}U nuclei at $E_{\gamma max}$ = 250, 600, and 1000 MeV and of ^{209}Bi and ^{197}Au nuclei at $E_{\gamma max}$ = 1000 MeV were studied using semiconductor detectors on the Kharkov linear accelerator Y-2000. It is established that in the fission of ^{238}U nuclei the mass distribution asymmetry is conserved up to $E_{\gamma max}$ = 1000 MeV. At the same time a dip in the total kinetic energy distribution of symmetric fragments is conserved. The photofission of ^{209}Bi and ^{197}Au nuclei results mainly in symmetric mass distributions and in monotonous dependence of the total kinetic energy on the extent of the mass asymmetry of fragments. The data for ^{209}Bi and ^{197}Au nuclei are compared with predictions of the Nix–Swiatecki theory. (auth)

47023 L X-RAY AND γ EMISSION OF ^{243}Am. Aleksandrov, B. M.; Grigor'ev, O. I.; Shimanskaya, N. S. Yadern. Fiz., 10: 14-17(July 1969). (In Russian).

Yields of the L x-rays (0.41 ± 0.05 quant/dec) and of the γ emission with the energies 43 keV (0.05 ± 0.01 quant/dec), 74.6 keV (0.73 ± 0.03 quant/dec), and 117 keV (0.0064 ± 0.0025 quant/dec) of ^{243}Am are measured by the $\alpha\gamma$ coincidence method. L x-ray and γ emissions were registered by a proportional gas–discharge counter filled with Xe and by a scintillation counter with the NaJ(Tl) crystal; α particles were registered by a Si detector. (auth)

47024 STUDY OF ^{117}Sn NEUTRON CROSS SECTIONS. Adamchuk, Yu. V.; Zenkevich, V. S.; Moskalev, S. S.; Muradyan, G. V.; Shchepkin, Yu. G. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 10: 18-26(July 1969). (In Russian).

The total cross section, radiative capture, and neutron cross sections of ^{117}Sn with the resolution 4, 12, and 30 nsec/m, respectively, were measured by the time-of-flight method. A statistical analysis of levels was made. The strength function was calculated. For a number of levels, spin and radiative width were determined. (auth)

47025 MEASUREMENT OF CROSS SECTION ISOMERIC RATIOS ON Xe ISOTOPES. Kardon, B.; Zamori, Z.; Sheresh, Z.; Groz, P. (Central Inst. of Physical Research, Budapest). Yadern. Fiz., 10: 27-30(July 1969). (In Russian).

Relative probabilities of emergence of metastable and ground states were determined for the isomeric pairs of ^{125,125m}Xe, ^{127,127m}Xe, ^{133,133m}Xe, and ^{135,135m}Xe obtained in the reactions (n,γ), i.e., isomeric ratios of cross sections of 0.031, 0.062, 0.063, and 0.068, were measured. (auth)

47026 ON ASYMMETRY AND ANISOTROPY IN A PHOTOFISSION OF ^{238}U NEAR THE THRESHOLD. Vorotnikov, P. E. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 9: 1197-1203(June 1969). (In Russian).

On basis of an analysis of data on photofission of ^{238}U near the threshold it is shown that the quasistable states with widths ~10^5 eV and separated with a 0.6 MeV gap, are essential for this process. These states are different for the dipole and quadrupole photofission and correspond apparently to a pear-shaped deformation of the fissile nucleus. Symmetry or asymmetry of the fragment mass distribution is determined by the deformation of the nucleus before the penetration through the barrier. The symmetric fragments are mainly due to the quadrupole fission. The fission barriers depend not only on the quantum numbers IK^π, but also on the character of deformation of the fissile nucleus. (auth)

47027 A STUDY OF NUCLEUS–NUCLEUS COLLISIONS IN THE HUNDREDS OF MeV REGION. Otterlund, I.; Resman, R. (Univ. of Lund, Sweden). Ark. Fys., 39: 265-93(1969).

Nucleus-nucleus collisions produced in nuclear emulsions by heavy cosmic ray primaries were studied for kinetic energies of primaries in the interval 100 ≲ E ≲ 500 MeV/nucleon. The angular distribution and the energy of all particles leaving the point of interaction were measured and the particles were in most cases identified. It is shown that the nucleon-nucleon cascade developed in a nucleus-nucleus interaction is rather well described simply as a superposition of cascades similar to those developed in nucleon-

nucleus interactions. The energy and angular distributions of the alpha-particles emitted with energies <14 MeV were studied. It was found that evaporation theory cannot account for most of these particles. In high energy nucleus-nucleus interactions the alpha-particles are produced partly by emission from disintegrating fragments and partly by a knock-on process in which quasielastic collisions between nucleons and alpha-clusters take place. There is a large spread in angles and energies of the alpha-particles produced in nucleus-nucleus interactions. To investigate if the knock-on process can account for this large spread we calculated the maximum energy of an alpha-particle knocked out with a given angle relative to the incident particle. It was found that the large spread in angles and energies can be understood if we choose reasonable values of the momenta of nucleons and clusters of nucleons inside the interacting nuclei. (auth) (Sweden)

47028 DECAY OF ^{185}Os. Cook, W. B.; Johns, M. W. (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 47: 1899-1911 (Sept. 15, 1969).

The energies and intensities of 10 transitions in ^{185}Re following the decay of ^{185}Os were determined using Ge(Li) detectors and a magnetic beta-ray spectrometer. Internal conversion measurements made at a resolution of 0.15% in momentum yielded the multipole character of the 9 strongest transitions. The proposed decay scheme was tested by a two parameter γ-γ coincidence experiment. The decay energy was found to be 1012 ± 3 keV from γ-x coincidence measurements involving the 646, 717, 875 + 880, and 931 keV transitions. (auth)

47029 STUDIES OF ENERGY DISTRIBUTION OF γ RAYS IN REACTIONS OF ^{159}Tb(n,n'γ). Romanenko, V. M.; Sit'ko, S. P.; Strizhak, V. I.; Shevchenko, V. A. (Kiev State Univ.). Ukr. Fiz. Zh., 14: 683-4(Apr. 1969). (In Russian).

The energy distribution of γ rays in ^{159}Tb reactions (n,n'γ) in the energy range from 0.4 to 2.15 MeV was studied with a specimen of ^{159}Tb weighing 5 g. Gamma transitions of ^{159}Tb of 0.62, 0.97, 1.29, 1.42, 1.75, and 1.97 MeV were identified. Transitions of 1.42, 1.75, and 1.97 MeV were observed for the first time. Plans were made for future studies of the newly observed level by means of superfluidity nuclear model. The regularities of energies of ^{159}Tb rotational levels differed significantly from the J(J + 1) law. (R.V.J.)

47030 ^{111}Ag AND ^{115}Cd YIELDS IN THE REACTOR NEUTRON FISSION OF ^{237}Np. Stella, Renato; Maxia, Vera; Moretto, Luciano (Univ., Pavia, Italy). Ric. Sci., 38: 1190-3(Dec. 1968).

The yields of ^{111}Ag and ^{115}Cd in the fission of ^{237}Np induced by reactor neutrons were determined relative to the corresponding yields from ^{235}U fission, using ^{140}Ba as an internal standard. ^{111}Ag yields were found to be 0.122 ± 0.007%; those of ^{115}Cd were 0.053 ± 0.003%. (J.G.B.)

47031 COULOMB EXCITATION OF THE COLLECTIVE SEPTUPLET AT 2.6 MeV IN ^{209}Bi. Hertel, J. W.; Fleming, D. G.; Schiffer, J. P.; Gove, H. E. (Univ. of Rochester, N. Y.). Phys. Rev. Lett., 23: 488-91(Sept. 1, 1969).

Beams of 18-MeV α particles and 70-MeV ^{16}O were used for E3 Coulomb excitation of the weak-coupling $3^-|h_{9/2}$ septuplet $J^\pi = 3/2^+, \ldots, 15/2^+$ at 2.6 MeV in ^{209}Bi. A complete decay scheme was obtained and short lifetimes were determined from observed Doppler effects. Several absolute transition probabilities were deduced for both excitation and decay involving the multiplet and low-lying single-particle states. (auth)

47032 ON THE ELECTRON-CAPTURE DECAY OF ^{133}Ba TO THE 437-keV LEVEL IN ^{133}Cs. Toernqvist, S.; Stroem, S. (Uppsala Univ.). Ark. Fys., 38: 261-5(1968).

The (L + M +...)/K capture ratio in the decay of ^{133}Ba to the 437-keV level in ^{133}Cs was measured with a method that is independent of detector efficiencies. The result, 0.45 ± 0.04, is in good agreement with that of G. Schulz, who used an entirely different technique. The influence of a newly discovered transition in ^{133}Cs on the capture ratios is discussed. (auth)(Sweden)

47033 A METHOD FOR ABSOLUTE DETERMINATION OF ^{238}U CAPTURE RATES. Bresesti, A. M.; Bresesti, M.; Neumann, H. (CCR-EURATOM, Ispra, Italy). J. Nucl. Energy, 23: 379-86(Aug. 1969).

The absolute determination of ^{238}U capture rates is described. The method was based on the utilization of a Ge(Li) gamma spectrometer for the measurement of the ^{239}Np activity. The high resolution of the Ge(Li) spectrometer allowed measurement of ^{239}Np even in the presence of fission product gamma activity. The efficiency calibration of the gamma spectrometer was performed by using ^{239}Np sources whose absolute activity was determined by $4\pi\beta^-$ counting. The results of the $4\pi\beta^-$ counting were found to be in good agreement with the results obtained by measuring ^{239}U, parent of ^{239}Np, by $4\pi\beta^-$-γ coincidence technique. (auth)(UK)

47034 NEUTRON SEPARATION AND PAIRING ENERGIES IN THE REGION $82 \leq N \leq 126$. Duckworth, H. E. (McMaster Univ., Hamilton, Ont. Univ. of Manitoba, Winnipeg); Barber, R. C.; Van Rookhuysen, P.; (and others). Phys. Rev. Lett., 23: 592-4 (Sept. 15, 1969).

Results of a systematic study of atomic-mass differences in the region $82 \leq N \leq 126$ are presented as plots of double-neutron separation energy and neutron-pairing energy. These plots provide information concerning the extent of the nuclear deformation which begins in the region of 90 neutrons, its dependence upon Z, and its gradual disappearance in the region $106 \lesssim N \lesssim 116$. (auth)

47035 MAGNETIC MOMENT OF ^{241}Pu. Gerstenkorn, S. (CEA, Saclay, France. CNRS, Orsay, France); Tomkins, F. S. Physica, 42: 581-6(June 12, 1969). (In French).

With the aid of a Fabry–Perot interference spectrometer HYPEAC and a source containing a sample of ^{241}Pu enriched to 94%, a precision measurement of the ratio of the magnetic moments μ_{241}/μ_{239} was made. A value of $\mu_{241}/\mu_{239} = -3.36_5 \pm 0.02$, was obtained compared to the value obtained by Bleaney et al., by paramagnetic resonance $\mu_{241}/\mu_{239} = 3.53 \pm 0.02$. From the known value $\mu_{239} = -0.200 \pm 0.004\mu_n$ obtained by direct measurement, it follows that $\mu_{241} = -0.67_3 \pm 0.015\mu_n$. (auth)

Nuclear Theory

Refer also to abstracts 45536, 46330, 46639, 46643, 46741, 46744, 46745, 46765, 46785, 46868, 46912, 46941, 46963, and 47002.

47036 (ANL-7535, pp 149-50) THE $1d_{3/2}$–$1f_{7/2}$ SINGLE-PARTICLE ENERGY. Hubbard, Lincoln B.; Williamson, Frank S.; Jolly, H. Paul (Argonne National Lab., Ill.).

Shell-model calculations were performed for A = 39, A = 41, and calcium-40 in order to clarify the $1d_{\frac{3}{2}} - 1f_{\frac{7}{2}}$ single-particle splitting at the A = 40 closed shell. A similar analysis was performed for ^{16}O. It was concluded that the splitting at the A = 40 shell has been overestimated by 20% or more. (J.W.R.)

47037 (BNL-13624) ORIENTED TARGETS IN NEUTRON SPECTROMETRY. Sailor, V. L. (Brookhaven National Lab., Upton, N. Y.). May 1, 1969. 89p. Dep. CFSTI.

A brief history of the use of oriented targets in neutron physics is presented. Some of the underlying theoretical concepts are reviewed and some experimental techniques discussed. The various applications are described and some of the experimental results are reviewed. The potentialities and the state-of-the-art are also discussed. A chapter on target technology is included. (J.W.R.)

47038 (BNL-tr-286) CORRELATION FOR CROSS SECTIONS OF THERMAL FISSION OF HEAVY NUCLEI. Romanov, Yu. F. Translated by Stephen J. Amoretty (Brookhaven National Lab., Upton, N. Y.), from At. Energ. (USSR), 26: 436-40(1969). 11p. Dep. CFSTI.

An abstract of this paper, prepared from the original language, appeared as NSA 23: 37245.

47039 (COO-427-93) INTERACTION OF PHOTONS AND PARTICLES WITH NUCLEI. Technical Progress Report, November 1, 1968–October 31, 1969. Mullin, Charles J. (Notre Dame Univ., Ind.). July 21, 1969. Contract AT(11-1)-427. 16p. Dep. CFSTI.

A brief summary is presented on the theoretical work done on the interactions of photons and particles with nuclei. The work covers the period November 1, 1968 to October 31, 1969. (J.W.R.)

47040 (CU-1019-72) DESCRIPTION OF THE COMPUTER CODE EVAMCO. Reedy, Robert C. (Columbia Univ., New York. Dept. of Chemistry). July 28, 1969. Contract AT(30-1)-1019. 27p. (CONF-690909-1). Dep. CFSTI.

From 158th National American Chemical Society, New York.

The computer code EVAMCO calculates the energy and angular momentum spectra of the particles emitted from a compound nucleus using an angular-momentum-dependent statistical theory for the evaporation of particles from an excited nucleus. The program gives the channel energy and orbital angular momentum distribution of the emitted particles as well as the angular momentum distribution of the corresponding residual nucleus for the emission of various particles from a compound nucleus. The program, which considers only the first particle emitted from the original compound nucleus, can include up to six different particles competing for emission, but does not consider gamma-ray competition. The program was written in FORTRAN IV for the IBM 360 series of computers. (auth)

47041 (ITEF-654) DEVIATIONS FROM THE STATISTICAL DESCRIPTION OF THE DISTRIBUTIONS OF THE SPACING BETWEEN THE NEUTRON LEVELS OF INTERMEDIATE AND HEAVY NUCLEI. Sukhoruchkin, S. I. (Gosudarstvennyi Komitet po Ispol'zovaniyu Atomnoi Energii SSSR, Moscow. Institut Teoreticheskoi i Eksperimental'noi Fiziki). 1969. 19p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Analysis of the correlation properties of neutron levels of a broad scope of nuclei is described. The method of comparison of the deviations from the statistical distributions in low-lying and highly excited nuclear states was applied to the energy intervals of several keV order of magnitude. Systematic correlations with the same parameters were found in both group of states, which indicates that the conditions of the statistical model at excitation energies close to the neutron binding energy are fulfilled incompletely. The model is discussed in which these correlations lead to the structure of several eV orders of magnitude. This structure is observable in neutron level spacing distributions of heavy N-even target nuclei. (auth)

47042 (ITF-69-31) THE OSCILLATOR FUNCTIONS AND THE NUCLEAR MATTER. [PART] II. Filippov, G. F. (Akademiya Nauk Ukrainskoi SSR, Kiev. Institut Teoreticheskoi Fiziki). 1969. 11p. (In Russian). Dep.

A number of questions, connected with the application of oscillator functions to the investigation of the nuclear matter is considered. (auth)

47043 (NP-17996) ON THE QUADRUPOLE MOMENT OF THE FIRST EXCITED STATES OF THE EVEN-EVEN SPHERICAL NUCLEI. Note No. 215. Boldrighini, C. (Rome Univ. (Italy). Istituto di Fisica). Apr. 14, 1969. 7p. Dep. CFSTI (U. S. Sales Only).

A simple model to relate the quadrupole moments of the first-excited states of spherical even-even nuclei to the low-lying spectra of neighboring even-odd nuclei is proposed. A simplified version of the Jean-Klein theory is used and pure j-j coupling is assumed. (J.W.R.)

47044 (SGAE-PH-77/1968) NEUTRON-PROTON SURFACE DELTA RESIDUAL INTERACTIONS IN SPHERICAL NUCLEI OF ODD MASS NUMBER. Reya, Ewald (Oesterreichische Studiengesellschaft fuer Atomenergie G.m.b.H., Seibersdorf). 1968. 104p. (In German). Dep.

Thesis. Submitted to Univ. of Vienna, Austria.

A theory for the determination of the structure, as for example, separation energy, energy levels, transition rates, etc., of spherical nuclei of odd mass number was developed under the fundamentals of a spin-independent p-p (or n-n) and a spin-dependent n-p surface delta residual reaction. After effecting a Bogoliubov-Valatin transformation, which corresponds to the quasiparticle representation, generalized coupled BCS equations could be derived. This coupling was facilitated by first order n-p self-energy terms, which represent a direct sequence of n-p residual reactions. In contrast to previously treated uncoupled BCS equations, these renormalizations, which necessitate the solution of a very complicated equation system, can represent, under application of a single-parametric surface reaction, binding energies, ground states, and low excited levels of a great number of odd nuclei with $40 \leq Z \leq 59$ and $53 \leq N \leq 82$ astonishingly well. It is proved that n-p reactions play a dominating role in the region considered. In order not to conflict with experiments, it is necessary to use corresponding coupling constants and not to postulate a 1/A dependence. For clarification of energetically higher excited states, a Tamm-Dancoff approximation was carried out in the 1- and 3-quasiparticle subspace of the total Hilbert space. The construction of suitable projection operators for the projection of spurious states of this approximation carried the particle number nonconservation, resulting from the Bogoliubov-Valatin transformation. The pertinent numerical calculations are tedious and complicated. For this reason the approximation was carried out only in some cases. It was shown for ^{109}Ag that the relative length of the $1/2^-$ ground state and the low-excited $9/2^+$ level was not essentially altered, whereas the $3/2^-$ and $1/2^+$ states undergo significant corrections. This is explainable by the additional consideration of 3-quasiparticle states. This also shows that the admixture of spurious components in the corresponding wave functions is extremely large. For the even isotopes, theoretical excitation energies can be found, which deviate in spots only by 0.03 MeV from experimental measurement results. (tr-auth)

47045 (UCRL-18891) MEASUREMENTS OF KAONIC X RAYS OF MEDIUM AND HEAVY ELEMENTS. Wiegand, Clyde E.; Kunselman, Raymond (California Univ., Livermore. Lawrence Radiation Lab.). Apr. 1969. Contract W-7405-eng-48. 19p. (CONF-690503-3). Dep. CFSTI.

From International Conference on Hypernuclear Physics, Argonne, Ill.

The x-ray spectra resulting from negative kaons stopped in targets of various medium and heavy elements were measured using Ge(Li) detectors. The spectra were analyzed for indications of neutron excess in the nuclear surface. It appears that kaonic atoms are a good tool for studies on the nuclear surface. (J.W.R.)

47046 (UCSD-10-P-11-68/69-95) APPLICATIONS OF STATISTICAL METHODS TO NUCLEAR STRUCTURE. Buchler, Jean Robert (California Univ., La Jolla, San Diego). 1969. Contract AT(11-1)-Gen-10. 191p. Dep. CFSTI.

An improved Thomas-Fermi theory is applied to nuclear structure with an energy density functional which is based on nuclear matter calculations with variable neutron excess, thus giving the theory a microscopic foundation. Both symmetry and Coulomb effects are treated properly. The only phenomenological parameter which enters the theory is adjusted so as to give the correct binding energies over a whole range of nuclei and its value is consistent with a theoretical estimate by Bethe. A systematic study of spherical nuclei was made over a whole range of A and Z. Binding energies and shapes (mass and charge radii and surface thicknesses) are in excellent agreement with experiment. The analysis also qualitatively confirmed the isotope shift, the parabolic dependence on Z, and lent support to the idea of a neutron halo. The statistical approach was used to derive the interaction potential between heavy ions with an application to $^{16}O-^{16}O$ scattering. The resulting potential is of the "molecular" type with a short range repulsion followed by an attraction. A χ^2 fit search has shown that a whole sequence of such potentials with increasing well depths give an identical fit to the 13 MeV angular distribution and equivalent phases modulo π. On physical grounds all but one of these can be eliminated (the maximum well depth is fixed by the binding energy of the ^{32}S compound nucleus). This best potential has a weaker repulsion and a deeper well than the theoretically derived potential. Polarization effects are shown to essentially increase the well depth giving an explanation for part of the discrepancy. The χ^2 search also revealed the presence of a small absorption. The α transfer reaction channel $^{20}Ne + ^{12}C$ was estimated to account for at most 30% of the total absorption and the excitation of the 3^- state was found to be negligible, indicating the weak transition to the multitude of open channels requiring the formation of a compound nucleus. A qualitative comparison of $^{16}O + ^{16}O$ with $^{16}O + ^{18}O$ scattering revealed an increased surface diffuseness in ^{18}O showing that ion-ion scattering can be a very useful tool for investigating the isotopic variation of nuclear structure. (auth)

47047 STRIPPING REACTIONS ON ODD-A NUCLEI INITIATED BY VECTOR-POLARIZED DEUTERONS. Kocher, D. C.; Haeberli, W. (Univ. of Wisconsin, Madison). Phys. Rev. Lett., 23: 315-17(Aug. 11, 1969).

Stripping reactions on odd-A nuclei to states of nonzero spin may involve two or more values of the total angular-momentum transfer j_n for the captured nucleon. Results for the reaction $^{53}Cr(d,p)^{54}Cr^*$ (Q = 6.71 MeV) initiated by vector-polarized deuterons, show that measurements of the vector analyzing power can be used to determine the separate cross-section contributions for the possible j_n values. (auth)

47048 ROTATIONAL ENERGY OF THE SYSTEM OF INTERACTING PARTICLES. Davydov, A. S.; Filippov, G. F. Nucl. Phys., A133: 135-45(1969).

The problem of separation of rotational motion in the system of interacting particles is considered. The conditions making it feasible are discussed. The correspondence between moments of inertia determining the energy of the system of rotational states and the distribution of the particles in the volume is ascertained for the case of four particles. (auth)

47049 MICROSCOPIC ASPECTS OF THE NUCLEAR COLLECTIVE MODEL. II. Holzwarth, Gottfried (Technische Hochschule, Munich). Nucl. Phys., A133: 161-76(1969).

The use of phenomenological generator coordinates in the variational approach to nuclear oscillations is examined. Criteria are presented which enable a comparison with exact RPA results and thus an indirect justification of the collective model. The admixing of low-lying two-quasiparticle states is discussed. The pairing-plus-quadrupole model seems to be unable to produce pronounced surface vibrations. (auth)

47050 ON A DESCRIPTION OF ODD-A ISOTOPES OF IRIDIUM BY A MODEL INCLUDING PARTICLE-VIBRATION AND PARTICLE-ROTATION COUPLING. Piepenbring, R.; Nopre, H. (Centre de Recherches Nucleaires, Strasbourg). Nucl. Phys., A133: 113-23(1969).

The spectroscopic properties of the low-lying levels of the odd-A isotopes of iridium are studied in the framework of a model including particle-vibration and particle-rotation coupling. It is

shown that the observed magnetic moments, the M1 transitions and the E2 transitions can be described in a satisfactory way by using Nilsson wave functions with $\mu = 0.45$ and $\eta \approx 1.25$ and by deducing the mixing coefficients of the wave functions from the known experimental energy levels. (auth)

47051 COLLECTIVE COORDINATES IN NUCLEAR PHYSICS. Gupta, Vijay Kumar. Saskatoon, Saskatchewan, Univ. of Saskatchewan, 1968. 228p.

Thesis.

A collective coordinate technique was developed to describe center of mass and collective rotational motions in nuclei. Collective of the form $\psi = \Phi_n(\text{coll.}) \times \chi$ (Intrinsic) exist. The Φ_n are eigenfunctions of some operator G which commutes with the many-body hamiltonian H and thus generates transformations that leave H invariant. One intrinsic coordinate is introduced for each laboratory coordinate. The redundancy is removed by a constraint ϕ on the intrinsic coordinates, which introduces a delta function $\delta(\phi)$ into the volume element. ϕ satisfies a soluble set of partial differential equations. The advantages of this technique are (1) the spurious center of mass or rotational states usually contained in descriptions of the intrinsic motions are eliminated and (2) wave functions with the proper symmetries can easily be constructed. The formalism was applied to specific problems to provide a comparison with other works. The vibrational problem of A one dimensional oscillators was solved within the framework of the collective coordinate idea. The rotational inertial parameter was estimated. (Diss. Abstr.)

47052 ITERATIVE METHOD FOR THE CALCULATION OF NUCLEAR LEVEL DENSITIES. Williams, Frederick C. Jr. (United States Naval Academy, Annapolis). Nucl. Phys., A133: 33-49(1969).

An improved method is presented for the calculation of nuclear level densities from single particle energy levels. The calculation is performed using a statistical approach but avoiding the usual mathematical approximations. Recursion relations are given for the calculation of coefficients of a finite order partition function for the case of non-interacting fermions and for the case in which the effect of residual interactions is approximated by a diagonal pairing energy for doubly degenerate states. Computer calculations of the level density are demonstrated for several simple models exhibiting structure in the single-particle level scheme and for the deformed nucleus single-particle Nilsson levels for the nuclei ^{30}Si, ^{31}P, ^{32}P and ^{32}S as a function of deformation parameter η and pairing energy Δ. Non-zero values of both parameters are required to obtain reasonable agreement with observed level densities at or below 8 MeV. (auth)

47053 RETARDED TRANSITIONS IN ^{181}Ta AND ^{175}Lu AND THE EFFECTIVE MAGNETIC MOMENT OPERATOR. Wahlborn, S.; Blomqvist, J. (Royal Inst. of Tech., Stockholm. Research Inst. for Physics, Stockholm). Nucl. Phys., A133: 50-64(1969).

The retarded transitions assigned as $\frac{5}{2}$, $\frac{5}{2}^+$ [402] $\rightarrow$ $\frac{7}{2}$, $\frac{7}{2}^+$ [404] in ^{181}Ta (482 keV) and ^{175}Lu (343 keV) are analyzed with special regard to the large hindrance of the M1 radiation in ^{181}Ta. The E2 component is dominated by the band mixing which is thus determined by B(E2). For the analysis of B(M1), we exploit the relation between the Coriolis and M1 intrinsic matrix elements. The result shows a marked difference between ^{181}Ta and ^{175}Lu. Calculations with extended models for particle motion indicate possible effects of the detailed deformation structure for the two cases. Furthermore, the predicted tensor term $k_2[Y^2,s]^1$ in the μ operator gives a significant contribution to B[M1], when k_2 is of the order of unity. The present data are consistent with the condition $k_2 \lesssim 0.6$, whereas $k_2 \gtrsim 0$ is preferred because of consistency with the model calculations. The effective magnetic moment operator can be written in the form $\mu \approx (g_l^0 + \delta g_l^{ex})\, l + (g_s^0 + \delta g_s^{pol} + \delta g_s^{ex})\, s + (k_2^{pol} + k_2^{ex})[Y^2,s]^1$, where g_l^0 and g_s^0 are the unrenormalized nucleon g-factors. The term δg_l^{pol} represents the well-known g_s renormalization due to spin polarization (δg_l^{ex} is small). We have estimated the pion-exchange contributions, giving $\tau_3 g_l^{ex} \approx 0.1$ and $\tau_3 k_2^{ex} \approx -1$. When our preferred range for k_2 from the present analysis is combined with previous data from other work, we can give the conservative semiempirical estimate $0 < \tau_3 k_2^{pol} \lesssim 2.5$ for the spin polarization contribution when this is assumed to have isovector character. (auth)

47054 EVALUATION OF E0 PAIR TRANSITIONS. Wilkinson, D. H. (Oxford Univ.). Nucl. Phys., A133: 1-9(1969).

Formulas, tables, and graphs are presented for the extraction of the E0 matrix element from the electron pair transition rate taking into account the Coulomb field of the emitting nucleus. A single-particle unit suitable for measuring the strength of such transitions is defined and recommended. (auth)

47055 RECOIL NUCLEI YIELD IN HIGH-ENERGY-PARTICLE REACTIONS. Berlovich, E. E.; Tarasov, V. K. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 738-40(Apr. 1969). (In Russian).

In the direct "on-line" studies of short-lived nuclei, the yield of reaction products from the target is of great interest; the recoil process is more important than the diffusion for single-charged ions. For protons accelerated to several MeV usually only the diffusion mechanism is taken into account. Studies with high-energy protons revealed that the yield of recoil nuclei with lifetimes in the order of seconds is comparable with the yield due to diffusion. In order to determine the relative yields, the diffusion length $4\sqrt{D/\lambda}$ and the flight path $\bar{R}$ must be compared. For most materials near the melting point D is about 10^{-8} cm^{-2} sec^{-1}. For nuclei with a lifetime of about 1 sec, of interest from the viewpoint of spectroscopy, the value of $\sqrt{D/\lambda}$ is about 10^{-4} cm. The value of $\bar{R}$ was estimated from experimental data on recoil nuclei. For lifetimes of about 1 second and less the recoil process is a nonnegligible role and under some conditions may exceed the diffusion yield. For concrete examples the exact value of the diffusion constant in the isotope under study should be known. (TTT)

47056 ABNORMAL BEHAVIOR OF THE HOLE LEVELS IN (d,p) REACTIONS. Litvin, V. F.; Nemilov, Yu. A.; Krasnov, L. V. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 358-60(Apr. 1969). (In Russian).

Decrease of the energy of the bombarding deuterons results in a shift of the main maximum of the differential (d,p) reaction cross section toward large emission angles, indicating that a stripping reaction takes place. However, experiments with nuclei of an intermediate weight (A $\approx$ 60) such as ^{59}Ni, ^{61}Ni, ^{63}Ni, and ^{65}Zn revealed an abnormal behavior of shifting toward smaller angles. The study indicated that the process is controlled by an empirical rule: hole levels in nuclei possessing a previous shell with a large l_n formed in (d,p) reactions exhibited an abnormal relation concerning the position of the main maximum of the angular distribution of protons as a function of the bombarding deuterons. This rule may be applied at present only with nuclei with A $\approx$ 60, E_d = 6 to 15 MeV. The behavior of hole levels in (d,p) reactions should be verified for other nuclei. (TTT)

47057 ANGULAR CORRELATIONS OF LINEARLY POLARIZED CASCADE PHOTONS. Lobov, G. A. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 618-20(Apr. 1969). (In Russian).

Types of reactions may be identified by measuring the linear polarization of photons emitted by excited nuclei, determining parity changes in radiative nuclear transitions. The previously obtained expressions for angular correlations were generalized for the case involving an arbitrary number of photons in the cascade. The spin moments of the upper excited state of the nucleus and of the subsequent states to that found after the nth transition were examined for a cascade consisting of n nuclear transitions. It was assumed that the radiation emitted in the first and nth transitions represent a mixture of ML and E(L + 1) multipoles. Expressions were derived for the angular correlations for the first and nth photons of the cascade without taking into account the angular correlations and polarization of the intermediate transitions. Expressions were derived also for describing the asymmetry in a generalized form. (TTT)

47058 ABNORMAL ROTATIONAL BAND OF THE DAVYDOV–CHABAN MODEL AND "SPHERIC" EVEN–EVEN NUCLEUS. Aldushchenkov, A. V.; Voinova, N. A.; Peker, L. K. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 621-5(Apr. 1969). (In Russian).

The Davydov model was intended to describe collective states of both deformed and spherical even–even nuclei. It predicts the existance of an abnormal rotational band with a series of 2^+, 3^+, 4^+ ... (K $\approx$ 2) spins. Earlier experimental data for spherical models were examined to determine how these levels are described by the Davydov–Chaban model. Davydov made use of the nonadiabatic parameter, which characterizes the "softness" of the nucleus with respect to longitudinal oscillations, and of the nonaxial behavior parameter which characterizes the deformation of the nucleus. The prediction of the model was compared with experimental data for isotopes ranging from ^{72}Ge to ^{196}Pt. On the basis of the properties of the Gd isotopes it was found that as the mass number A is increased, the agreement between the theoretical and experimental data is improved. Similar studies were made for the Pt and Os isotopes. Good agreement between theoretical and experimental data was found for transition probabilities from levels of abnormal rotational bands to lower rotational level for nuclei with A = 150 to 190. The Davydov–Chaban model may be applied in this range. Experimental transition probability data are subject to large errors. (TTT)

47059 POSSIBILITY OF DELAYED ^{3}He AND ^{3}H DECAYS OF NUCLEI. Berlovich, E. E.; Novikov, Yu. N. (Ioffe Inst. of

Physics and Tech., Leningrad). Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 679-85(Apr. 1969). (In Russian).

A study was carried out to determine the possibility whether under certain conditions ground states of nuclei could emit nucleon groups overloaded with a certain type of nucleons such as the ^{3}H, ^{3}He, ^{6}He, ^{8}Be nuclei, etc. It can be shown that the boundary of instability with respect to such decay lies beyond the limits of nucleon stability; therefore, no such kind of radioactivity has yet been observed. If the excitation energy is larger than the bond energy of the (x,y) association in the nucleus (whereby x is the number of protons and y the number of neutrons, a decay with such emission may be expected. Such excited levels may be created by β decay. The decay chains involving emission of ^{3}He and ^{3}H are: $(Z_1N_1) \xrightarrow{\beta} (Z_1 - 1,N + 1)^* \xrightarrow{^3He} (Z_1 - 3,N_1) + (2,1)$ (I) $(Z_2,N_2) \xrightarrow{\beta^-} (Z_2 + 1,N_2 - 1)^* \xrightarrow{^3H} (Z_2,N_2 - 3) + (L,2)$ (II), whereby the * designates the excited state of the nucleus. In experiments involving fission and spallation by protons and neutrons, the delayed ^{3}He and ^{3}H particles may be identified as follows: delay time of not more than $\sim 10^{-2}$ sec; the spectrum of emitted particles consists of separate monoenergetic lines of not more than a few MeV. Study of these decay processes is expected to clarify the properties of nuclear with anomalous Z/N ratios. (TTT)

47060 STATIC QUADRUPOLE MOMENTS OF THE FIRST 2^+ LEVELS OF SPHERICAL NUCLEI. Birbrair, B. L. Izv. Akad. Nauk SSSR, Ser. Fiz., 33: 665-9(Apr. 1969). (In Russian).

The lack of success of attempts to calculate quadrupole moments in the two-quasi-particle approximation is not due to the fact that the nonharmonic character has not taken into account but that all physical processes involved in the quadrupole moment of the 2^+ state are neglected even in the traditional 2-particle approximation. This problem was examined, using phonon moments of non-superfluid nuclei, keeping in mind that from the viewpoint of the microscopic theory, the phonon is the correlative state of the particle-hole pair. Renormalization processes of the external field have not been considered in earlier studies; it is known that residual interaction between quasiparticles affects strongly the static moments of the one-particle states and therefore should not be neglected when studying the static moments of the 2^+ states. (TTT)

47061 STATISTICAL DISTRIBUTIONS FOR RANDOM NUCLEAR HAMILTONIANS. Bloch, C. (CEN de Saclay, Gif-sur-Yvette, France). J. Phys. Soc. Jap., 26: Suppl., 57-60(1969).

From Conference on Statistical Mechanics, Kyoto, Japan. See CONF-680928.

A new approach to the Gaussian law for the residual two-body interaction matrix elements in the statistical model is described. The method is based on a direct consideration of the structure of the matrix elements. (J.W.R.)

47062 QUENCHING OF GAMOW–TELLER MATRIX ELEMENTS AND ISOVECTOR MAGNETIC MOMENTS IN MIRROR NUCLEI. Leonardi, R. (Univ., Bologna); Rosa-Clot, M. Nuovo Cim., Lett., 1: 829-34(June 1, 1969).

The mechanism of the quenching effect on the matrix elements for the isovector magnetic moment operator is discussed. (J.W.R.)

47063 SU(3) SYMMETRY AND REALISTIC INTERACTIONS. Flores, J. (Univ. Nacional Autonoma de Mexico, Mexico City). pp 188-91 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18–20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.

See CONF-680440.

A computer program was developed previously to construct the wave functions for a system of particles in the 2s-1d shell and the matrix elements with respect to them of an arbitrary two-body interaction. The wave functions are classified in the SU(3) scheme, that is, they correspond to a definite orbital symmetry and a given irreducible representation (λ,μ) of the SU(3) group; total orbital angular momentum, total spin and isospin are also good quantum numbers of the states so constructed. The results of the calculation for ^{20}Ne and ^{20}O are shown. Also results were obtained for ^{18}O and ^{19}F. (J.F.P.)

47064 THIRD SYMPOSIUM ON THE STRUCTURE OF LOW-MEDIUM MASS NUCLEI, LAWRENCE, KANSAS, APRIL 18–20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968. 301p. $12.50. (CONF-680440).

Separate abstracts were prepared for the 13 papers included. (J.W.R.)

For abstracts of individual papers see: 46871, 46872, 46929, 46930, 46955–46960, 47063, 47065, and 47066.

47065 EFFECTIVE INTERACTIONS IN NUCLEI AND TWO-NUCLEON SCATTERING. Koltun, Daniel S. (Univ. of Rochester, N. Y.). pp 23-47 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18–20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.

See CONF-680440.

Several ways in which the residual interaction can be related back to the two-nucleon problem are discussed. Methods for obtaining the two-body effective interaction are described and information from phase shift studies is reviewed. (J.W.R.)

47066 NUCLEAR FORCES AND THE STRUCTURE OF LIGHT NUCLEI. Elliott, J. P. (Univ. of Sussex, Brighton, Eng.). pp 48-72 of Third Symposium on the Structure of Low-Medium Mass Nuclei, Lawrence, Kansas, April 18–20, 1968. Davidson, J. P. (ed.). Lawrence, Kan., University Press of Kansas, 1968.

See CONF-680440.

The advantages of using realistic interactions in calculating nuclear structure properties of light nuclei are discussed. Some of the techniques used in calculations employing realistic interactions are described. Some results for several light nuclei are analyzed. (J.W.R.)

47067 MAGNETIC DIPOLE GAMMA-RAY STRENGTH FUNCTION IN DEFORMED NUCLEI, AND NEUTRON-CAPTURE GAMMA RAYS. Shapiro, C. S.; Emery, G. T. (Indiana Univ., Bloomington). Phys. Rev. Lett., 23: 244-6(Aug. 4, 1969).

The magnetic dipole gamma-ray strength function for some strongly deformed heavy nuclei is computed on the basis of the Nilsson model, pairing, and a residual spin–spin interaction. The strength of the spin–spin interaction is adjusted to give average agreement with experiment of effective spin g factors for low-energy M1 transitions and moments. Predictions are made for average M1 widths of primary transitions following neutron capture; the predictions are in reasonable agreement with recent data. (auth)

47068 ASYMMETRY OF ANALOG LEVELS AND OTHER DOORWAY STATES. McVoy, K. W. (Los Alamos Scientific Lab., N. Mex.). Ann. Phys. (N.Y.), 54: 17-26(Aug. 1969).

The S-matrix description of the energy-asymmetry of isobaric analog states is reviewed in a model-independent way, in order to emphasize its relation to unitarity and its very simple Argand-diagram representation. As de Toledo Piza and Kerman have pointed out, this same type of asymmetry can occur in any resonance superimposed on a non-elastic background, and so can be expected in other types of doorway states, as well. (auth)

47069 UNDERGRADUATE EXPERIMENT TO FIND NUCLEAR SIZES BY MEASURING TOTAL CROSS SECTIONS FOR FAST NEUTRONS. Minor, T. C.; Martin, F. D.; Montgomery, H. E. Jr.; Okun, L. M.; Fowler, J. L. (Oak Ridge National Lab., Tenn.). Amer. J. Phys., 37: 649-54(June 1969).

Pu–α–Be neutron sources, now available in many college laboratories, used with stilbene crystal detectors and proper circuits for neutron-gamma discrimination, permit students to measure fast-neutron total cross sections for a number of easily obtained samples. From these measurements they may calculate the size of nuclei and, using elements covering a wide range of the periodic table, demonstrate the constant density of nuclear matter. (auth)

47070 CONTRIBUTION TO ISOTOPE SHIFTS BY THE CHARGE DISTRIBUTION WITH A NEUTRON: A NAIVE, FIRST-ORDER PERTURBATION APPROACH. Ter Bush, Robert (California State Polytechnic Coll., Pomona). Amer. J. Phys., 37: 479-80(May 1969).

The contribution of the charge distribution within a neutron to the isotope shift is estimated by means of a first-order perturbation approach employing a simplistic model of the neutron. This "neutron shift," $(\Delta E)_{N',N}$, of an isotope with neutron number N′ relative to that with neutron number N is shown to be given by $(\Delta E)_{N',N} \cong -|e|^2\rho_e(N' - N)\langle r_0^2\rangle/10\epsilon_0$, where $-|e|\rho_e$ is the electronic charge density at the nucleus, and r_0 is the effective radius of the negative charge cloud of the neutron as determined from electron-scattering data. A specific case, the neutron shift of ^{135}Cs relative to ^{133}Cs, is worked out, and the neutron shift is seen to be small compared to the "volume-effect" shift, but of comparable magnitude to the experimental error associated with the measurement of the latter. (auth)

47071 INVESTIGATIONS OF PARITY DEFORMATION IN SPHERICAL NUCLEI. Burr, W.; Schuette, D.; Bleuler, K. (Univ., Bonn). Nucl. Phys., A133: 581-9(1969).

The possibility of parity deformation for spherical structures is investigated from various viewpoints. Several criteria of stability for the spherical Hartree-Fock solution (Thouless condition,

critical 0^- states in different approximations) as well as different types of two-body forces (a realistic effective interaction and the OPEP) and single-particle spectra (HF, oscillator, Woods-Saxon and experimental) are used in order to obtain a complete survey. The result is that parity deformation can be excluded in practically all cases. In addition, the positions of the two critical 0^- states of ^{16}O are in good numerical agreement with experiments if realistic forces and experimental single-particle energies in connection with the random phase or Tamm-Dancoff approximation are used. (auth)

47072 SIMPLIFIED METHOD FOR ACCOUNT OF TENSOR FORCES IN RESIDUAL INTERACTION OF NUCLEONS. Rudak, E. A. (Inst. of Physics, Minsk). Yadern. Fiz., 10: 74-7(July 1969). (In Russian).

A possible simplified account of tensor forces in the residual interaction of nucleons is considered in terms of the shell model. (auth)

47073 BANDS OF SURFACE CLUSTER STATES IN NUCLEI. Baz, A. I.; Man'ko, V. I. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 10: 78-89(July 1969). (In Russian).

Arguments are presented that practically every nucleus must have a series of surface cluster levels at high excitation energies (10 to 30 MeV). Every such series is connected to the threshold of a two-body decay of the nucleus. Experimental data available now support these predictions. (auth)

47074 VARIATION OF THE DENSITY MATRIX DUE TO ADDITION OF A LARGE NUMBER OF PARTICLES TO THE FERMI SYSTEM. Osadchiev, V. M.; Troitskii, M. A. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 10: 90-3(July 1969). (In Russian).

A method is presented for calculation of the variation of the one-particle density matrix due to addition of a large number of particles. As a result it is possible to calculate the variation of the mean value of a one-particle operator. (auth)

47075 IS IT POSSIBLE TO DESCRIBE LOWER STATES OF EVEN NUCLEI USING ONLY COLLECTIVE DEGREES OF FREEDOM? Grechukhin, D. P. (Inst. of Atomic Energy, Moscow). Yadern. Fiz., 10: 94-106(July 1969). (In Russian).

All experimental data known to Jan. 1, 1968 for mixed $(M_1 + E_2)$ transitions of even nuclei in the region $16 \leq A \leq 254$, are analyzed. Comparison of experimental data with the results following from consistent phenomenological description of collective excitation of nuclei, shows that in the region $A \leq 50$ the application of such models is meaningless, in the region $50 \leq A \leq 150$ the application of such models is very doubtful and only in the regions $150 \leq A < 190$ and $230 < A$ the application of phenomenological collective models is reasonable. The accuracy of the experimental data is not, however, high and thus the conclusions should be taken as preliminary. (auth)

47076 HARD-CORE INTERACTION AND THE THREE-NUCLEON PROBLEM. Efimov, V. (Ioffe Inst. of Physics and Tech., Leningrad). Yadern. Fiz., 10: 107-12(July 1969). (In Russian).

Representing the two-nucleon repulsion at small distances by the hard-core interaction, as is often done, the three-nucleon problem is shown to be exactly solvable (the problem is reduced to a solution of a one-dimensional equation). (auth)

47077 ANALYSIS OF MEASUREMENTS OF FISSION FRAGMENT YIELDS IN TERMS OF STATISTICAL MODEL. Dyachenko, P. P.; Kuzminov, B. D.; Tarasko, M. Z. Yadern. Fiz., 10: 61-4 (July 1969). (In Russian).

It is shown that the absence of sufficiently exact data on densities of states of fragments at the moment of spallation of the nucleus is one of the reasons for failure in description of the fission process at low excitation energies. It follows from the analysis that the change of the curve of the sum kinetic energy dependence of fragments on their masses with the increase of the excitation energy of a fissile nucleus can be understood assuming the density parameters of fragment levels to be dependent on their deformation. (auth)

47078 EFFECTS OF THE SHELL STRUCTURE OF THE FRAGMENTS AT NUCLEAR FISSION. Rubchenya, V. A. Yadern. Fiz., 9: 1192-6(June 1969). (In Russian).

Shell corrections to the masses of deformed nuclei calculated by the method of Strutinsky are applied to account for shell effects on the configuration of the fissile nucleus in the moment of the separation. Calculation using Fong's statistical model provides a reasonable agreement with experiment for mean kinetic energy of fragments and for their deformation energy if applied to the "thermal" fission of ^{235}U and to the spontaneous fission of ^{252}Cf. (auth)

47079 PROTON SPECTRA IN DIRECT DISINTEGRATION OF NUCLEI BY HIGH ENERGY ELECTRONS. Vysotskii, G. L.; Vysotskaya, A. V. (Physical-Technical Inst., Kharkov). Yadern. Fiz., 9: 1177-83(June 1969). (In Russian).

Spectra of protons emerging in the reaction (e,e'p) at high energies of incident electrons are studied in the impulse approximation and assuming a one-particle mechanism. Proton spectra as well as electron spectra in the region of quasielastic maximum are determined mainly by the momentum distribution of nucleons in nucleus. Different momentum distributions are discussed, and in particular, the influence of the proton wave distortion resulting from the diffraction interaction in final state. The spectra obtained for disintegration are scaled for the case of the photoprocess. Multipolarities of higher orders are taken into account by the momentum distribution. (auth)

47080 SIZE AND SHAPE OF ATOMIC NUCLEI. Baranger, Michel; Sorensen, Raymond A. Sci. Amer., 221: No. 2, 59-64; 66; 72-3(Aug. 1969).

A survey is presented of the experimental knowledge and theoretical description of the size and shape of nuclear models. The use of electron scattering and nucleon inelastic scattering in determining structure properties is discussed. The various nuclear models used in interpreting the experimental data are briefly reviewed. The use of the collective model in studying the energetics of deformation is described. (J.W.R.)

47081 CORRELATION BETWEEN VARIATIONS OF NUCLEAR RADII (ISOTOPIC DISPLACEMENT) AND BINDING ENERGY IN THE NEIGHBORHOOD OF THE MAGIC NUMBERS N = 28, 50, 82. Gerstenkorn, Simon (CNRS, Orsay, France). Compt. Rend., Ser. B, 268: 1636-9(June 23, 1969). (In French).

The observed anomalies in the relative isotopic displacements of elements possessing a magic number of neutrons (N = 28, 50, 82) suggest the existence of a simple correlation between the binding energies per nucleon and the variations of nuclear radii. The proposed correlation implies locally the abandonment of the generally acknowledged law $R = r_0 A^{\frac{1}{3}}$; the interpretation of isotopic displacements in the optical spectra requires a lessening of the nuclear radius when the mass increases in the neighborhood of the magic numbers $(N-4, N-2, N)$. The consideration of the variations of binding energies per nucleon allows for the first time a quantitative expression to be given for this phenomenon. It is thus shown for example that the strontium isotope 84 must have a nuclear radius larger than the isotope 88: R (^{84}Sr > R ^{86}Sr > R ^{88}Sr). Likewise in the case of calcium one finds also the anomaly R (^{44}Ca > R ^{48}Ca). (tr-auth)

47082 CONSIDERATION OF NEUTRON–PROTON CORRELATIONS IN LIGHT NUCLEI BY THE GREEN FUNCTION METHOD. Afanas'ev, G. N. Izv. Akad. Nauk Kaz. SSR, Ser. Fiz.-Mat., No. 4, 66-76(July-Aug. 1968). (In Russian).

The Green function method was used to study nuclei with two-particle interactions in S = 0, T = 1 states. It was found that the energy is a minimum for identically equal n-p correlation functions in addition to the case of no correlation. (J.W.R.)

47083 NUCLEAR ENERGY POTENTIALS AS FUNCTION OF QUANTUM NUMBER OF THE MODEL HAMILTONIAN SYMMETRY GROUP. Vanagas, V. V.; Kalinauskas, R. K. Liet. Fiz. Rinkinys, Liet. TSR mokslu Akad., Liet. TSR Aukst. Mokylos, 8: 465-7(1968). (In Russian).

Interpretations of nuclear spectra are based on four conditions: exchange forces, SU_3—the invariant internucleon interactions, the spallation spectrum L, and spin-orbital interactions. An attempt was made to calculate the first three conditions. (R.V.J.)

47084 OPTICAL MODEL AND GIANT RESONANCES. Morsy, M. W.; Hanna, K. M. (Atomic Energy Establishment, Cairo). Atomkernenergie, 14: 323-8(1969).

A new formalism of the optical model is proposed on the basis of a generalized Hartree–Fock approach, in which all participating nucleons move in a single particle potential, and obeying boundary conditions which are to be associated with giant resonances. These boundary conditions are in general complex, which in addition to the complex eigenenergies of the experimentally observed giant resonances, render the eigenparameters of the single particle potential to be complex. A standard method is developed for extracting the eigenparameters of any arbitrary single particle potential, which not only reproduce the excitation energies and the widths of the experimental observed giant resonances, but also is consistent with the nuclear size data provided by electron scattering. (auth)

47085 ON DETECTING THE RECOILLESS EMISSION OF INTERNAL CONVERSION ELECTRONS; AUGER ELECTRONS, AND β PARTICLES. Carlson, D. E. (Army Nuclear Defense Lab., Edgewood Arsenal, Md.). Phys. Lett., 29A: 449-50(June 30, 1969).

It is shown that the recoilless emission of low-energy internal conversion electrons, Auger electrons, and β-particles could be detected as temperature dependent effects in spectra obtained with high resolution β-spectrometers. (auth)

47086 METHOD FOR THE ANALYSIS OF PURE QUADRUPOLE SPECTRA IN NUCLEAR GAMMA-RAY RESONANCE. Shenoy, G. K.; Dunlap, B. D. (Argonne National Lab., Ill.). Nucl. Instrum. Methods, 71: 285-91(1969).

A method was described to analyze the pure quadrupole spectra measured in nuclear gamma-ray resonance experiments, which does not require complex diagonalization routines. The resonance line positions and their intensities have been expressed as polynomials in the asymmetry parameter η, for various excited and ground state nuclear spins. The procedure has been programmed in Fortran IV. Some useful illustrations and applications are given. (auth)

47087 COULOMB ENERGIES AND THE EXCESS NEUTRON DISTRIBUTION FROM THE STUDY OF ISOBARIC ANALOG RESONANCES. Auerbach, Naftali; Huefner, Joerg; Kerman, A. K.; Shakin, C. M. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Lett., 23: 484-8(Sept. 1, 1969).

The effects determining the energies of isobaric analog resonances are studied. In particular, the compound and continuum shifts, nuclear two-body correlations, isospin-nonconserving nuclear forces, and isospin impurity are discussed. These effects are important in deriving the excess neutron density from analog-resonance experiments. (auth)

47088 TESTS OF THE EXTENDED R-MATRIX THEORY OF NUCLEAR REACTIONS. Garside, L. (Univ. of California, Berkeley); Tobocman, W. Ann. Phys. (N. Y.), 53: 115-32(June 1, 1969).

The extended R-matrix theory of nuclear reactions is a generalization of the R-matrix formalism that makes it possible to calculate the collision matrix from the compound nucleus eigenstates provided by any nuclear structure calculation. In addition, optical potentials for each channel may be used to represent the nonresonant part of the collision matrix. To test the extended R-matrix formalism (ERF) it was applied to simple, soluble, two channel, S-wave scattering models. The ERF was found to be superior to the standard R-matrix formalism (SRF). Like the SRF, the ERF results are very sensitive to the choice of the channel radius parameters. In addition the ERF is plagued by the appearance of narrow "false resonances." A modification of the ERF called the X-matrix formalism (XF) completely eliminates the dependence on the matching radius. The XF is found to give fairly good results in our model calculations and reduces the false resonance difficulty. However, the XF has the drawback of being sensitive to a set of boundary condition parameters whose values will be somewhat ambiguous in practical calculations. This shortcoming is eliminated in the modification X-matrix formalism (MXF) which is found to give excellent results for the two channel model and shows no false resonances. It is concluded that the MXF is the version of choice among the various versions of the ERF. (auth)

REACTOR TECHNOLOGY

Commercial Power Reactors

Refer also to abstracts 45437, 45449, 46087, 46101, 47150, and 47291.

47089 (ANL–7520(Pt.2), pp 39–51) REMOTE RETRIEVAL AND REMOVAL OPERATIONS IN THE FERMI REACTOR. Johnson, Kenneth P. (Power Reactor Development Co., Monroe, Mich.); Matte III, Joseph (Atomic Power Development Associates, Inc., Detroit, Mich.).

Operations in the Fermi Fast Breeder Reactor associated with the visual observation, manipulation, and removal of the Zr segments are described. The development of remote handling and remote viewing equipment is reviewed. Segment removal procedures are discussed. 5 references. (D.C.C.)

47090 (ANL–7520(Pt.2), pp 154–66) PLANT DESIGN PROBLEMS ASSOCIATED WITH THE APPLICATION OF VENTED FUEL TO A FAST BREEDER REACTOR. Bruzzi, L.; Gondoni, G. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)); Lindsey, P. S.; Mueller, R. E. (Atomic Power Development Associates, Inc., Detroit, Mich.).

The design problems for altering an existing fast reactor and for developing a new fast reactor to accommodate vented PuO_2–UO_2 fuel elements are described. Alterations required for the Trino Power Reactor to accept vented fuel elements are analyzed. Fission gas production by vented fuel elements and containment requirements are discussed. A waste disposal system for a fast breeder reactor with vented fuel elements is described. 5 references. (D.C.C.)

47091 (ANL–7520(Pt.2), pp 243–53) PHENIX: STATUS OF THE DESIGN BEFORE CONSTRUCTION. Carle, R. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Crette, J. P. (Groupement Atomique Alsacienne Atlantique, le Plessis-Robinson (France)); Leduc, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Moreau, J. C. (Electricite de France, Chatou. Centre de Recherches et d'Essais); Rozenholc, M. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Villeneuve, J. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires).

The construction schedule for the Phenix Fast Reactor is presented. Modifications in design parameters are described. 4 references. (D.C.C.)

47092 (APED–5652) STABILITY AND DYNAMIC PERFORMANCE OF THE GENERAL ELECTRIC BOILING WATER REACTOR. Carmichael, L. A.; Scatena, G. J. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1969. 146p. Dep. CFSTI.

The physical and phenomenological characteristics pertinent to stability analyses are described for the three portions of the plant evaluated in the BWR design process, i.e., total plant, core, and channel hydrodynamic characteristics. A description is given of the stability criteria and its theoretical basis followed by a description of the analytical methods used in evaluating the BWR, each method being substantiated by experimental data. Lastly, a parametric evaluation of the current BWR design is made for the total plant, reactor core, and channel hydrodynamic performance over a wide range of operating conditions. These analyses have been derived from and are supported by test data from Boiling Water Reactors currently in operation. The detailed information presented demonstrates the technical proficiency of the design and substantiates the operational stability chatacteristics of the integrated nuclear steam supply system. 13 references. (auth)

47093 (APED–5698) SUMMARY OF RESULTS OBTAINED FROM A TYPICAL STARTUP AND POWER TEST PROGRAM FOR A GENERAL ELECTRIC BOILING WATER REACTOR. Carmichael, L. A.; Diefenderfer, D. W.; Foreman, C. E.; Larson, L. H. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1, 1969. 176p. Dep. CFSTI.

Details of the startup of the Gundremmingen Power Reactor are given. The sequential guide for power testing is listed; startup organization and responsibilities are described. Startup test results are outlined. Results of primary system vibration measurements are tabulated; results of core neutronics and systems temperature balance tests are shown graphically. Low-range power-monitor (LRPM) test results are given. Details of pressure transient tests are given; recorder traces of actual data are included. Actual data for pump and generator trip tests are shown; data on isolation transients are tabulated. Problems which developed during startup are summarized. (M.L.S.)

47094 (APED–5750) DESIGN AND PERFORMANCE OF GENERAL ELECTRIC BOILING WATER REACTOR MAIN STEAM LINE ISOLATION VALVES. Rockwell, D. A.; van Zylstra, E. H. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept. Commonwealth Edison Co., Chicago, Ill.). Mar. 1969. 137p. Dep. CFSTI.

The results of an extensive test program on the basic design of the large main steam line isolation valves use in commercially available boiling water reactors are given. Effects of mass flows, mixture qualities, and closing times were tested under coolant loss accidents. Design drawings of the commercially available large valves, used for isolation, are shown. The valve testing program is described. Data are shown graphically and in tabular form. (M.L.S.)

47095 (APED–5756) ANALYTICAL METHODS FOR EVALUATING THE RADIOLOGICAL ASPECTS OF THE GENERAL ELECTRIC BOILING WATER REACTOR. Horton, N. R.; Williams, W. A.; Holtzclaw, J. W. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 1969. 112p. Dep. CFSTI.

The mathematical models and conversion factors which are used in evaluating the safety aspects of the boiling water power reactor are detailed. The following aspects of a hypothetical coolant loss accident are discussed: containment response analysis, core heatup analysis, fission product release from fuel, iodine partition and decontamination factors, fission product behavior in the primary containment, fission product activity in the primary and secondary containment, and fission product activity released to the environment. The following additional hypothetical accidents are considered: steam line break, refueling, control rod drop, fission product to the atmosphere, and radiological effects. Parameters used by G. E. for accident analysis calculations are tabulated. 55 references. (M.L.S.)

47096 (DOCKET-1155–7) LA CROSSE BOILING WATER REACTOR. Twenty-Fifth Monthly Operational Report, July 1969. (Allis-Chalmers Mfg. Co., Bethesda, Md. Atomic Energy Div.). Sept. 8, 1969. Contract AT(11-1)-850. 44p. (ACNP–69507). Dep. CFSTI.

47097 (DOCKET-50003–7) INDIAN POINT STATION, [UNIT 1]. Provisional Operating License No. DPR-5. Semiannual Operations Report No. 7, August 1, 1965–January 31, 1966. (Consolidated Edison Co. of New York, Inc., New York). Mar, 18, 1966. 29p. Dep. CFSTI.

47098 (DOCKET-50003–8) INDIAN POINT STATION, [UNIT 1]. Provisional Operating License No. DPR-5. Semiannual Operations Report No. 9, October 1, 1966–March 31, 1967. (Consolidated Edison Co. of New York, Inc., New York). June 14, 1967. 27p. Dep. CFSTI.

47099 (DOCKET-50010–46) DRESDEN NUCLEAR POWER STATION, UNIT 1. License No. DPR-2: Technical Specifications, Change No. 18. (Commonwealth Edison Co., Chicago, Ill.). Sept. 11, 1969. 13p. Dep. CFSTI.

An authorized change in type of fuel assemblies for the Dresden Power Reactor Unit 1 is described. The change consists of a core loading of up to 85 Type 7 and 11 Type 7-Pu fuel assemblies. The change would be initiated at the end of the sixth operating cycle. Fuel element data for cycle 7 are listed. (D.C.C.)

47100 (DOCKET-50010–47) DRESDEN NUCLEAR POWER STATION, UNIT 1. DESCRIPTION AND HAZARDS EVALUATION REPORT OF CHANGE TO THE RAD-WASTE DISCHARGE LINE. (Commonwealth Edison Co., Chicago, Ill.). Sept. 15, 1969. 3p. Dep. CFSTI.

A proposed change in the Dresden Power Reactor Unit 1 radwaste system is described. The change consists of an alternate piping route to be used when maintenance is required on the Unit 1 system. Procedures for operating the alternate piping system are described. (D.C.C.)

47101 (DOCKET-50016–26) ENRICO FERMI ATOMIC POWER PLANT, [UNIT 1]. [Monthly] Report, July 1969. (Power

Reactor Development Co., Detroit, Mich.). Sept. 25, 1969. 10p. (PRDC-EF-71). Dep. CFSTI.

47102 (DOCKET-50029-100) YANKEE NUCLEAR POWER STATION. Operation Report No. 104, August 1969. (Yankee Atomic Electric Co., Boston, Mass.). Sept. 23, 1969. 15p. Dep. CFSTI.

47103 (DOCKET-50029-101) YANKEE NUCLEAR POWER STATION. Operation Report No. 75, March 1967. (Yankee Atomic Electric Co., Boston, Mass.). Apr. 20, 1967. 8p. Dep. CFSTI.

47104 (DOCKET-50133-3) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Final Hazards Summary Report, Amendment 13, Addendum A. (Pacific Gas and Electric Co., San Francisco, Calif.). Feb. 26, 1962. 175p. Dep. CFSTI.

Questions concerning the Final Hazards Summary Report are answered regarding: (1) Mechanical and Electrical Design; (2) Reactor and Process Instrumentation and Control; (3) Reactor System Thermal and Hydraulic Design; (4) Radioactive Materials Monitoring; (5) Reactor Physics; (6) Organization and Procedures; (7) Accident Analyses. Appendices include data on the design and fabrication of the reactor pressure vessel and on personnel qualifications. Revised pages for the Technical Specifications are included. (H.D.R.)

47105 (DOCKET-50133-4) REPORT ON INCREASED CORE FLOW RESISTANCE DUE TO CORROSION PRODUCT SCALING OF FUEL. License No. DPR-7. (Pacific Gas and Electric Co., San Francisco, Calif.). Feb. 1966. 21p. Dep. CFSTI.

Information is presented on a change in the core operating characteristics following an outage and on fuel assembly defect determinations during refueling and containment system modifications. The increase in core flow resistance was concluded to be the result of corrosion product scale spalling off the surfaces of fuel rods and lodging on fuel bundle spacers. Modifications were planned for the end of the operating cycle to eliminate the source of scale forming corrosion products. The procedures followed for determining the presence of fuel cladding defects on individual fuel assemblies using the dry sipping technique are presented. (H.D.R.)

47106 (DOCKET-50133-5) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Technical Specifications, Change No. 20. (Pacific Gas and Electric Co., San Francisco, Calif.). Aug. 19, 1966. 10p. Dep. CFSTI.

Proposed changes in stack emission rate for gaseous activity as authorized in the Technical Specifications are denied. Analyses of meteorological and atmospheric diffusion data and the stack emission history are included. (H.D.R.)

47107 (DOCKET-50133-6) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Technical Specifications, Change No. 21 and Addendum A. (Pacific Gas and Electric Co., San Francisco, Calif.). Oct. 20, 1966. 12p. Dep. CFSTI.

Proposed changes in the design of poison curtains and the use of updated calculations of nuclear, thermal, and hydraulic characteristics of the core loading scheduled for November 1966 are authorized. The principal change in the poison curtains is an increase of boron concentration from 900 ppM to 3700 ppM. The updated core characteristics are tabulated. (H.D.R.)

47108 (DOCKET-50133-7) LETTER DISCUSSING METAL-WATER REACTION FOR A HYPOTHETICAL LOSS OF COOLANT ACCIDENT WITHOUT CORE COOLING. (Pacific Gas and Electric Co., San Francisco, Calif.). Aug. 23, 1967. 5p. Dep. CFSTI.

The metal-water reaction problem in a hypothetical loss-of-coolant accident with failure of core cooling systems is discussed for Zircaloy clad Type II reload fuel. The metal-water reaction termination temperature, extent of the reaction as a function of termination temperature, and pressure capability of the containment system are examined. (H.D.R.)

47109 (DOCKET-50133-8) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Revised and Original Technical Specifications, Amend. 12. (Pacific Gas and Electric Co., San Francisco, Calif.). June 7, 1968. 211p. Dep. CFSTI.

The principal design features and operating limits and requirements which have an effect on the safety of operation of the power plant are presented. Described in separate sections are the: site, containment system, nuclear steam supply and turbine plant systems, reactor core, reactor protection system, monitoring systems, waste disposal systems, and administrative and procedural safeguards. (H.D.R.)

47110 (DOCKET-50133-9) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Preliminary Hazards Summary Report, Amendment 27. License No. DPR-7; Change No. 22. (Pacific Gas and Electric Co., San Francisco, Calif.). June 7, 1968. 305p. Dep. CFSTI.

Data are presented to support a request that the Provisional Operating License be converted to a Final Operating License. Included in the data are: the financial qualifications of the Pacific Gas and Electric Company, the Technical Specifications, a tabulation of estimated fuel transfers, a statement of operating experience to date, and a proposed form of the Final Operating License. (H.D.R.)

47111 (DOCKET-50133-10) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Technical Specifications, Change No. 23. (Pacific Gas and Electric Co., San Francisco, Calif.). Sept. 20, 1966. 13p. Dep. CFSTI.

Data are presented to support proposed changes in the Technical Specifications arising from proposed changes in refueling. The refueling changes concern the use of Zircaloy clad fuel and an improved design for poison curtains. Revised calculated thermal and hydraulic characteristics for the core loading are included. (H.D.R.)

47112 (DOCKET-50133-11) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Preliminary Hazards Summary Report, Amendment 24. License No. DPR-7; Change No. 16. (Pacific Gas and Electric Co., San Francisco, Calif.). Dec. 18, 1964. 31p. Dep. CFSTI.

Results of the uprating test program are presented showing satisfactory performance of the plant at reactor power levels up to 230 MW(t). Authorization is requested to: (1) increase the normal reactor power level license limit to 240 MW(t), (2) operate the reactor in the pressure range of 1000 to 1150 psig, and (3) set the reactor low water level scram as low as 1.25 ft below the top of the chimney. (H.D.R.)

47113 (DOCKET-50133-12) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Technical Specifications, Change No. 25. (Pacific Gas and Electric Co., San Francisco, Calif.). Mar. 24, 1969. 33p. Dep. CFSTI.

Design specifications are presented for Type III fuel assemblies proposed for loading in 25% of the core at each refueling. The assemblies have a 6×6 array of 36 fuel rods. The Type III fuel consists of Gd_2O_3 burnable poison blended with UO_2. Fuel cladding is Zircaloy-2 tubes. The design will enable the fuel to achieve an average burnup of 18,750 MWd/t. (H.D.R.)

47114 (DOCKET-50133-13) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Technical Specifications, Change No. 26. (Pacific Gas and Electric Co., San Francisco, Calif.). May 12, 1969. 3p. Dep. CFSTI.

Proposed revised pages of the Technical Specifications are presented. The revisions concern the on-site and off-site electrical power sources needed for plant operation. (H.D.R.)

47115 (DOCKET-50133-14) PROCEDURE FOR INSPECTION AND TESTING FOLLOWING AN EARTHQUAKE. (Pacific Gas and Electric Co., San Francisco, Calif.). Apr. 18, 1968. 3p. Dep. CFSTI.

47116 (DOCKET-50133-15) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7; Facility Operating License. (Pacific Gas and Electric Co., San Francisco, Calif.). Jan. 21, 1969. 181p. Dep. CFSTI.

The plant full term license and revised Technical Specifications for operation at 240 MW(t) are presented. Also included are an estimated schedule of fuel transfers, a safety evaluation by the Division of Reactor Licensing, and a report on the tsunami hazard at the plant site. (H.D.R.)

47117 (DOCKET-50133-16) REPORT ON PRIMARY SYSTEM LEAKAGE DETECTION. (Pacific Gas and Electric Co., San Francisco, Calif.). Jan. 27, 1969. 16p. Dep. CFSTI.

Information is presented on systems and procedures for the detection of small primary system leaks. Leak detection is based on a 50 gallon increase in the normal 380 gallon drywell lower head shielding water. The equipment is capable of detecting leaks of 0.1 gpm in short periods of time. A report on the program for inspection and testing of the reactor pressure vessel and

primary system and emergency core cooling system piping, valves, and other components is included. (H.D.R.)

47118 (DOCKET-50133-18) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7: Technical Specifications, Change No. 24. (Pacific Gas and Electric Co., San Francisco, Calif.). Dec. 23, 1968. 4p. Dep. CFSTI.

Authorization is requested for a change in the Technical Specifications involving the critical heat flux correlation for evaluation of core thermal limits. The new correlation is based on more recent data applicable to the geometry and flux conditions present in four- and nine-rod test sections. (H.D.R.)

47119 (DOCKET-50133-19) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. Operations Report, January 1–June 30, 1969. (Pacific Gas and Electric Co., San Francisco, Calif.). Sept. 15, 1969. 19p. Dep. CFSTI.

47120 (DOCKET-50133-20) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7. Operations Report, August 16, 1965–February 15, 1966. (Pacific Gas and Electric Co., San Francisco, Calif.). Apr. 1, 1966. 33p. Dep. CFSTI.

47121 (DOCKET-50133-21) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7. Operations Report, February 16–August 15, 1966. (Pacific Gas and Electric Co., San Francisco, Calif.). Sept. 26, 1966. 16p. Dep. CFSTI.

47122 (DOCKET-50133-22) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. License No. DPR-7. Operations Report, August 16, 1966–February 15, 1967. (Pacific Gas and Electric Co., San Francisco, Calif.). Apr. 5, 1967. 28p. Dep. CFSTI.

47123 (DOCKET-50133-23) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. [License No. DPR-7]. Operations Report, January 1–June 30, 1968. (Pacific Gas and Electric Co., San Francisco, Calif.). Aug. 19, 1968. 19p. Dep. CFSTI.

47124 (DOCKET-50133-24) HUMBOLDT BAY POWER PLANT, UNIT NO. 3. [License No. DPR-7]. Operations Report, July 1–December 31, 1968. (Pacific Gas and Electric Co., San Francisco, Calif.). Feb. 19, 1969. 39p. Dep. CFSTI.

47125 (DOCKET-50155-13) BIG ROCK POINT NUCLEAR PLANT. License No. DPR-6. Operations Report, November 1, 1965–April 30, 1966. (Consumers Power Co., Jackson, Mich.). June 24, 1966. 20p. Dep. CFSTI.

47126 (DOCKET-50155-14) BIG ROCK POINT NUCLEAR PLANT. License No. DPR-6. Operations Report, May 1–October 31, 1966. (Consumers Power Co., Jackson, Mich.). Dec. 23, 1966. 16p. Dep. CFSTI.

47127 (DOCKET-50155-15) BIG ROCK POINT NUCLEAR PLANT. License No. DPR-6. Operations Report, November 1, 1966–April 30, 1967. (Consumers Power Co., Jackson, Mich.). May 29, 1967. 11p. Dep. CFSTI.

47128 (DOCKET-50244-24) ROBERT E. GINNA NUCLEAR POWER PLANT, UNIT NO. 1. REPORT ON INSPECTION OF LOWER INTERNALS. (Rochester Gas and Electric Corp., N. Y.). Sept. 8, 1969. 2p. Dep. CFSTI.

Results of an inspection and damage analysis on the pressure vessel lower intervals of the Robert E. Ginna Power Reactor Unit 1 are presented. The damage was incurred during a transfer operation by crane. (D.C.C.)

47129 (DOCKET-50245-16) MILLSTONE NUCLEAR POWER STATION, UNIT 1. [Final Safety Analysis Report], Amendment 16. (Connecticut Light and Power Co., Hartford. Hartford Electric Light Co., Conn. Western Massachusetts Electric Co., Greenfield. Millstone Point Co., Wethersfield, Conn.). Sept. 4, 1969. 56p. Dep. CFSTI.

Effects of losing the Millstone Point Power Reactor, Unit 1 from the New England Power Exchange grid are evaluated. Reliability of onsite and offsite electric power systems are evaluated with respect to single failures. 4 kV and 480 V bus critical load distributions are tabulated. Reactor-vessel pressure- and water-level instrumentation is described; design criteria are given. The primary-containment-isolation system is described with respect to a single failure analysis. Schematics of the recirculation flow monitors are given. Cable installation criteria and bases are described. Safety margins available to the ECCS under accident conditions are detailed; data are shown graphically. Effects of loss-of-load transients on the Millstone Power Reactor Unit 1 systems are analysed in detail. A systematic description of a typical reactor startup is given. (M.L.S.)

47130 (DOCKET-50266-14) POINT BEACH NUCLEAR PLANT, UNITS NO. 1 AND 2. [Final Facility Description and Safety Analysis Report]. (Wisconsin Electric Power Co., Milwaukee. Wisconsin Michigan Power Co., Appleton, Wis.). Sept. 9, 1969. 307p. (DOCKET-50301-11). Dep. CFSTI.

Changes in officers and directors of the Wisconsin Electric Power Company and the Wisconsin Michigan Power Company, owners of Point Beach Power Reactor, Units 1 and 2, are listed. Codes and classifications for containment structure electrical penetrations are listed; containment structure design is detailed. The gas-monitoring system is described. Cable installation and routing is discussed. The integrity of core and internals is analyzed. Detailed Technical Specifications and bases are included. (M.L.S.)

47131 (DOCKET-50312-10) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Construction License CPPR-56; VSL Tendon System, Attachment A. (Sacramento Municipal Utility District, Calif.). Sept. 1969. 13p. Dep. CFSTI.

Additional information concerning the Rancho Seco Power Reactor VSL tendon system is presented. (D.C.C.)

47132 (DOCKET-50312-11) RANCHO SECO NUCLEAR GENERATING STATION, UNIT NO. 1. Construction Permit CPPR-56; Supplemental Information on VSL Tendon System, Attachment B. (Sacramento Municipal Utility District, Calif.). Sept. 1969. 261p. Dep. CFSTI.

Additional information concerning the Rancho Seco Power Reactor VSL tendon system is presented. (D.C.C.)

47133 (DOCKET-50313-13) ARKANSAS NUCLEAR ONE. Preliminary Safety Analysis Report, Amendment 11. (Arkansas Power and Light Co., Little Rock). Sept. 22, 1969. 146p. Dep. CFSTI.

Additional information concerning the Russellville Power Reactor liner plate anchorage tests and bearing plate tests is presented. (D.C.C.)

47134 (DOCKET-50320-15) THREE MILE ISLAND NUCLEAR STATION, UNIT 2. Safety Evaluation by the Division of Reactor Licensing. (Metropolitan Edison Co., Reading, Pa. Jersey Central Power and Light Co., Morristown, N. J.). Sept. 5, 1969. 105p. Dep. CFSTI.

Additional information concerning the Three Mile Island Power Reactor, Unit 2, is presented. (D.C.C.)

47135 (DOCKET-50323-8) DIABLO CANYON, UNIT 2. [Preliminary Safety Analysis Report], Amendment 5. (Pacific Gas and Electric Co., San Francisco, Calif.). Sept. 10, 1969. 177p. Dep. CFSTI.

Financial data on the owners of the Diablo Canyon Power Reactor, Unit 2, are given in support of the application for construction permit and operating license. The 1968 Annual Report for the Pacific Gas and Electric Company is included. Additional information concerning the reactor systems and design parameters is also included. (D.C.C.)

47136 (NUS-TM-S-33) ELK RIVER REACTOR FAILED FUEL ELEMENT DETECTION. Klein, L. T. (NUS Corp., Washington, D. C.). Aug. 15, 1966. 21p.

Four techniques that have been used for detecting failed fuel elements in boiling water reactors are discussed. Two methods, a multiport sampling system and flux depression testing, are determined to be unsatisfactory for installation in the Elk River Reactor (ERR). The two most promising methods, wet sipping and dry sipping, are evaluated in detail. It is concluded that the dry sipping technique is the most sensitive of the methods investigated and that provisions should be made for its use in the ERR. (H.D.R.)

47137 (TID-25176) A STUDY OF THE DESIGN AND CONSTRUCTION PRACTICES OF PRESTRESSED CONCRETE AND REINFORCED CONCRETE CONTAINMENT VESSELS. Final Report. Tan, Chen Pang (Franklin Inst. Research Labs., Philadelphia, Pa.). Aug. 1969. Contract W-7405-eng-26; Subcontract 2997. 506p. (FC-2121). Dep. CFSTI.

For Oak Ridge National Lab., Tenn.

The current practices in the design and construction of prestressed concrete and reinforced concrete containments for water-cooled nuclear reactors in civilian power application are

reviewed. The features of the different types of concrete containments are described. The specified service and predicted environmental conditions are identified, along with an evaluation of the effects of these parameters on structural behavior. Modes of failure are examined and possible use of models to study the actual behavior is indicated. Criteria used in the design of concrete containments are presented. Problems in the earthquake-resistant, tornado-resistant designs as well as missile protection are deliberated. Materials properties along with methods of specifying and selecting critical materials for service in the environments of interest are summarized. The need and importance of quality assurance both in design and construction are emphasized. The codes and standards applied in the technology are discussed and areas where augmentation and/or revision to these standards appears warranted are identified. The need of developing operational testing requirements for concrete containments is indicated. (auth)

47138 (TID-25187) GARIGLIANO NUCLEAR POWER PLANT. Operation Report for the 1st Quarter of 1969. (Ente Nazionale per l'Energia Elettrica, Rome (Italy)). Mar. 31, 1969. 19p. Dep. CFSTI.

Operations and maintenance required during January to March 1969 are described. Core configurations and control rod patterns are illustrated. Plant chemistry and radiation monitoring measurements are presented for January to March 1969. (D.C.C.)

47139 OPERATIONAL BEHAVIOUR OF NUCLEAR POWER STATIONS WITH HELIUM TURBINE. Kuper, K. D. Energ. Tech, 20: 275-8(Sept. 1968). (In German).

The 25 MW(e) station in Geesthacht-Tesperhude contains a He cooled reactor from which the highly heated He is passed directly to the turbine. The operational behavior and controls are considered. These deal with the He-turbine circuit and behavior of the plant during startup, shutdown, and sudden loss of load. (UKAEA Info. Bull.)

47140 WINFRITH HEATH NUCLEAR POWER STATION: COMMISSIONING AND OPERATIONAL EXPERIENCE. Hobrecker, H.-P. Brennst.-Waerme-Kraft, 21: 261-3(May 1969). (In German).

The SGHWR went critical on Sept. 14, 1967 and was brought up to power on Jan. 25, 1968. While bringing the reactor up to power, the turbogenerator was tested, system oscillations were measured, radiation was monitored, the systems and components were tested, and the automatic monitoring system was started. In-pile radiation and reactivity and water chemistry were checked. All systems operated satisfactorily. (J.M.J.)

47141 THE RECENT STATE AND TRENDS OF DEVELOPMENT IN MEASURING AND CONTROL TECHNIQUES FOR NUCLEAR POWER PLANTS. Missbach, M.; Bischoff, E.; Rehfeld, G.; Kromer, H. (VEB Kernkraftwerksbau, Berlin). Kernenergie, 12: 189-98(June 1969). (In German).

Measuring techniques including thermodynamics instrumentation, special conditions for sensing elements, and aspects of instrument engineering are described for power reactors. Process control and signalization, safety systems, and automatic control in nuclear power plants are analyzed. Tasks of the process computer in nuclear power plants are described. 104 references. (auth)

47142 EXPERIMENTAL BOR REACTOR AND SUPPORTING EXPERIMENTAL TESTS. Leipunskii, A. I.; Blagovolin, S. M.; Baturov, B. B.; (and others) (Inst. of Physics and Energetics, Obninsk, USSR). Kernenergie, 12: 198-202(June 1969). (In German).

The BOR reactor is a 60 MW research fast neutron Na-cooled reactor which is now under construction at Melekess, Ulyanovsk region. The reactor components and systems are described. Physical and engineering characteristics of the reactor are given. Some experiments carried out in connection with design problems of the reactor equipment are reviewed. 1 reference. (auth)

47143 COMPUTATIONS CONCERNING THE OPERATIONAL BEHAVIOUR OF THE RHEINSBERG NUCLEAR POWER PLANT REACTOR DURING THE FIRST PERIOD OF OPERATION. Beer, K.; Meyer, K.; Thomas, S.; Wockenfuss, H. (VEB Kernkraftwerksbau, Berlin). Kernenergie, 12: 163-6(May 1969). (In German).

Included is a brief report on the theoretical foundations of the fuel burn-up and duration of campaign computation methods in the Rheinsberg nuclear power plant, realized in the shape of the programmes PYTHIA and SIBYLLE. Usefulness of the computation technique is demonstrated in the light of results of computing the parameters of the first campaign of the power plant, which are compared with experimental data. (auth)

47144 SHAFT-SEALING ARRANGEMENTS FOR TURBOMACHINES HAVING GASEOUS WORKING-MEDIUM HEATED IN A NUCLEAR REACTOR. (to Escher Wyss Aktiengesellschaft). British Patent 1,164,201. Sept. 17, 1969. Priority date Jan. 14, 1966, Switzerland.

COMPRESSORS—seal for gas cooled, power reactor turbo, design parameters of nitrogen pressurized labyrinth gland
REACTORS, GAS-COOLED—compressor of power, design parameters of nitrogen pressurized labyrinth gland seal for turbo
REACTORS, POWER—compressor of gas cooled, design parameters of nitrogen pressurized labyrinth gland seal for turbo
SEALS AND GLANDS—design parameters of nitrogen pressurized labyrinth, for gas cooled power reactor turbocompressor (D.C.C.)

47145 SOCIAL BENEFIT VERSUS TECHNOLOGICAL RISK. Starr, Chauncey (Univ. of California, Los Angeles). Science, 165: 1232-8(Sept. 19, 1969).

An approach is presented for establishing a quantitative measure of benefit relative to cost for accidental deaths arising from technological developments in public use. The analysis is based on the assumptions: (1) that historical national accident records are adequate for revealing consistent patterns of fatalities in the public use of technology and (2) that such historically revealed social preferences and costs are sufficiently enduring to permit their use for predictive purposes. A risk-benefit analysis is carried out for a number of voluntary and involuntary societal activities. The criteria for acceptance of risk are applied to nuclear power plant safety. It is concluded that nuclear plant engineering design objectives determined by economic criteria alone would result in a design-target risk level very mucy lower than the present socially accepted risk for electric power plants. (H.D.R.)

47146 HARTLEPOOL: A MILESTONE IN GAS COOLED REACTORS. McKean, J. D. (British Nuclear Design and Construction, Whetstone, Eng.). Nucl. Eng. Int., 14: 724-30(Sept. 1969).

The more important aspects of design of the latest AGR reactor are considered. The advantages of pod boilers and their influence on the design of the pressure vessel are discussed. A brief description is also given of the circulators, the core and refueling arrangements, and the electrical system. The station layout is described and illustrated. Mean parameters are given and future developments assessed. (UK)

47147 SURVEY OF THE UNITED KINGDOM NUCLEAR INDUSTRY. Nucl. Eng. Int., 14: 714-48(Sept. 1969).

The following topics are reviewed: Nuclear power in the CEGB system; the reorganization of the British nuclear industry; reactor development work on gas-cooled and fast reactors; the nuclear fuel industry; operating experience and outages at CEGB nuclear stations; construction methods; and manufacture of special nuclear equipment. The Hartlepool reactor is described. The design features of a Mark III gas-cooled reactor (HTR) are given. A detailed discussion of refuelling of HTR's is presented. A pull-out chart showing the relationship of Government and industrial organizations is included. (UK)

47148 MONITORING THE CONTROL-ROD OPERATION OF THE NUCLEAR REACTOR AT DODEWAARD (NETHERLANDS). van der Kooi, H. (Philips Industrial Equipment Div., Eindhoven, Netherlands). Philips Tech. Rev., 30: 48-50(1969).

The heat generated in the reactor of the Dodewaard power station is controlled as a function of time and location in the core by varying the insertion of the control rods. A computer system has been designed which continuously compares the adjustments made by the reactor operator with the prescribed procedure and prevents incorrect operation. In particular the system ensures that the "reactivity worth" of the individual control rods does not exceed the known safe value. (auth)

47149 COMMON FEATURES AND DIFFERENCES IN THE CONSTRUCTION AND OPERATION OF NUCLEAR AND CONVENTIONAL POWER PLANTS. Weckesser, A. Mitt. Ver. Grosskesselbetr., 48: 261-9(Aug. 1968). (In German).

Nuclear and conventional steam generators are compared. Problems presented by the size and weight of pressure vessels and other components needed for pressurized water and boiling water reactors are analyzed. Operational aspects with special reference to loading and unloading of the Gundremmingen reac-

tor are described. A stability test on this reactor is presented. Differences in water analysis, embrittlement of steel exposed to neutrons, atmospheric contamination and nuclear accidents are also discussed. (UKAEA Info. Bull.)

Power Reactor Development

Refer also to abstracts 45182, 45369, 45983, 45985, 46144, 46145, 47235, and 47287.

47150 (ANL-7520(Pt.2)) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON SODIUM TECHNOLOGY AND LARGE FAST REACTOR DESIGN, NOVEMBER 7-9, 1968. PART II. SESSIONS ON LARGE FAST REACTOR DESIGN. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 435p. (CONF-681106(Pt.2)). Dep. CFSTI.

Information on all aspects of design and development of fast reactors and liquid Na-cooled fast breeder reactors is included. Separate abstracts are included for 25 of the 26 papers presented. One of the papers was previously included in NSA and may be located in the Report Number Index under CONF-681106. (D.C.C.)

For abstracts of individual papers see: 45458, 46036, 47089-47091, 47151, 47153-47165, 47182, 47207, 47218, 47228, and 47232.

47151 (ANL-7520(Pt.2), pp 3-19) SODIUM TECHNOLOGY CONSIDERATIONS IN FAST REACTOR DESIGN. Wolfe, B.; Zebroski, E. L. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation).

A review of various plant configurations for Na-cooled fast reactors is presented. Refueling and fuel storage problems associated with Na-cooled reactors are described. Maintenance difficulties with operating Na-cooled reactors are reviewed. Hypothetical accidents are analyzed. Cost experience for the SEFOR is presented. The effects of fast neutrons and liquid Na on swelling and corrosion of Type 316 stainless steel are described. Design restrictions due to clad swelling are discussed. Fission gas emissions and carbon transfer in Na-cooled fast reactor systems are analyzed. Boiler design problems are described. 35 references. (D.C.C.)

47152 (ANL-7520(Pt.2), pp 20-3) STATUS OF SODIUM TECHNOLOGY IN FRANCE. Delisle, J. P. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Faure, J. (Electricite de France, Chatou. Centre de Recherches et d'Essais); Gollion, H. J. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); Milliat, J. P. (Electricite de France, Chatou. Centre de Recherches et d'Essais); Vautrey, L. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires); Villeneuve, J. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires).

A review of the development of liquid Na-cooled reactors in France is presented. Component development problems and operation performance for the Rapsodie reactor are reviewed. 2 references. (D.C.C.)

47153 (ANL-7520(Pt.2), pp 77-85) REFERENCE CONCEPTS OF THE JAERI LARGE FAST REACTOR DESIGN STUDIES. Nozawa, M.; Iwaki, T.; Takahashi, J.; Terasawa, S.; Shiozuka, H.; Fujita, M. (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment).

Design parameters for two conceptual 1000 MW(e) liquid Na-cooled fast breeder reactors in Japan are compared. The parameter comparisons include: core and reactor system; coolant system and power-generating system; safety; and economics. 7 references. (D.C.C.)

47154 (ANL-7520(Pt.2), pp 86-9) SPECIAL ENGINEERING PROBLEMS INVOLVED IN THE JAERI DESIGN STUDIES. Shiozuka, H.; Nozawa, M.; Iwaki, T.; Takahashi, J.; Terasawa, S.; Fujita, M. (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment).

Design problems associated with the two conceptual 1000 MW(e) liquid Na-cooled fast breeder reactors in Japan are analyzed. Topics discussed include: core designs; fuel-handling system and rotating core; boiler; and control and instrumentation. (D.C.C.)

47155 (ANL-7520(Pt.2), pp 90-8) REASONS FOR CHOICE OF MAJOR MECHANICAL DESIGNS IN THE JAERI DESIGN STUDIES. Takahashi, J.; Nozawa, M.; Iwaki, T.; Terasawa, S.; Shiozuka, H.; Fujita, M. (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment).

The characteristics and reasons for choice for mechanical designs of the reactor systems in two designs of the Japanese 1000 MW(e) liquid Na-cooled fast breeder reactor are presented. (D.C.C.)

47156 (ANL-7520(Pt.2), pp 110-20) PLANT SYSTEM PARAMETRIC STUDY ON SODIUM-COOLED PROTOTYPE FAST BREEDER REACTOR. Yoshimi, H.; Nozawa, M.; Shiozuka, H.; Nara, Y.; Terasawa, S.; Yamamoto, H.; Takahashi, J.; Iwaki, T. (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment).

The optimum design parameters for a Japanese prototype 200 to 400 MW(e) liquid Na-cooled fast breeder reactor are presented. (D.C.C.)

47157 (ANL-7520(Pt.2), pp 130-46) DESIGN CONSIDERATIONS AND EXPERIMENTAL PROGRAM FOR THE COMMON DEVELOPMENT OF A 300-MWe SODIUM-COOLED FAST BREEDER PROTOTYPE SNR BY A BELGIAN-DUTCH-GERMAN CONSORTIUM. Harde, R. (Internationale Atomreaktorbau G.m.b.H., Bensberg (West Germany)).

The research and development programs for the Belgian-Dutch-German 300 MW(e) prototype liquid Na-cooled fast breeder reactor are reviewed. Design considerations include: accident and safety analysis; plant layout; reactor physics; plant safety; fuel elements; and Na technology. 15 references. (D.C.C.)

47158 (ANL-7520(Pt.2), pp 171-214) ATOMICS INTERNATIONAL 1000-MWe LMFBR FOLLOW-ON STUDY PROGRESS REPORT. Aronstein, R. E.; Ash, E. B.; Casey, D. F.; Golan, S.; Lancet, R. T. (Atomics International, Canoga Park, Calif.).

The major considerations, evaluations, and analyses which led to the selection of the Atomics International 1000 MW(e) LMFBR reference design are described. Optimum design parameters and component illustrations are presented. 10 references. (D.C.C.)

47159 (ANL-7520(Pt.2), pp 215-39) BABCOCK AND WILCOX 1000-MWe LMFBR FOLLOW-ON STUDY REFERENCE DESIGN. Croft, M. W.; Goulding, B. J.; Hostetler, D. R.; Honig, H. (Babcock and Wilcox Co., Lynchburg, Va.).

The major considerations, evaluations, and analyses which led to the selection of the Babcock and Wilcox 1000 MW(e) LMFBR reference design are described. Optimum design parameters and component illustrations are presented. 13 references. (D.C.C.)

47160 (ANL-7520(Pt.2), pp 254-68) DESIGN STUDIES ON THE REFERENCE FAST POWER PLANT (PCC-2). Cicognani, G.; Fogagnolo, G.; Pierantoni, F.; Tarantini, A. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)).

The optimum economic core design parameters and plant general design parameters are presented for the reference 1000 MW(e) PCC-2 liquid Na-cooled fast breeder reactor in Italy. 7 references. (D.C.C.)

47161 (ANL-7520(Pt.2), pp 291-330) DEVELOPMENT AND EVALUATION OF THE COMBUSTION ENGINEERING ADVANCED 1000-MWe LMFBR DESIGN. Noyes, Richard C.; Gilbertson, Jon C.; Menzel, Gerhart; Prabulos, J. J. Jr.; Staker, William P. (Combustion Engineering, Inc., Windsor, Conn.).

The major considerations, evaluations, and analyses which led to the selection of the Combustion Engineering 1000 MW(e) LMFBR reference design are described. Optimum design parameters and component illustrations are presented. 23 references. (D.C.C.)

47162 (ANL-7520(Pt.2), pp 345-57) THE EFFECT OF USING DIFFERENT SAFETY CRITERIA AND SELECTED SAFETY STUDIES FOR A 1000-MWe SODIUM-COOLED FAST REACTOR. Murphy, P. M.; Sherer, D. B.; Gibson, A. S. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation).

The major considerations, evaluations, and analyses employed in the safety studies for the General Electric 1000 MW(e) LMFBR reference design are described. Design parameters are compared for advanced and conservative safety criteria. 5 references. (D.C.C.)

47163 (ANL-7520(Pt.2), pp 358-68) ALTERNATE CORE DESIGN PARAMETERS AND ECONOMIC TRADE-OFFS FOR A 1000-MWe SODIUM-COOLED FAST REACTOR. Sherer, D. B.; Sangster, W. A.; Sciacca, F. W. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation).

The major considerations, evaluations, and analyses which led to the selection of the General Electric 1000 MW(e) LMFBR reference design are described. Optimum design parameters are presented. 3 references. (D.C.C.)

47164 (ANL-7520(Pt.2), pp 369-87) PLANT DESIGN, SYSTEM OPTIMIZATION, AND EQUIPMENT SELECTION FOR AN ADVANCED LMFBR. Gibson, A. S.; Boardman, C. E.; Germer, J. H. (General Electric Co., Sunnyvale, Calif. Advanced Products Operation).

The major considerations, evaluations, and analyses which led to the selection of the Argonne National Laboratory 1000 MW(e) LMFBR reference design are described. Optimum design parameters and component illustrations are presented. 2 references. (D.C.C.)

47165 (ANL-7520(Pt.2), pp 388-416) THE WESTINGHOUSE 1000-MWe FOLLOW-ON STUDY. Kelly, J. C. R. Jr.; Biancheria, A.; Anderson, C. A. Jr.; Hobson, R. G.; Beckett, E. F. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.).

The major considerations, evaluations, and analyses which led to the selection of the Westinghouse 1000 MW(e) LMFBR reference design are described. Optimum design parameters are presented. 13 references. (D.C.C.)

47166 (CNM-R-2(Vol.1), pp 1-15) ARGENTINA'S NUCLEAR PROGRAM. Quihillalt, O. A. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). (In Spanish).

Past activities of Argentina's National Commission on Atomic Energy are reviewed. General organization of the Commission is discussed. Activities of the research centers are described. Use of nuclear power plants for supplying the electricity needs of the greater Buenos Aires area in the near future is considered. (M.L.S.)

47167 (CNM-R-2(Vol.1), pp 70-93) U. S. PROGRESS IN NUCLEAR ENERGY. Ramey, James T. (Atomic Energy Commission, Washington, D. C.).

Power reactor development in the U. S. is reviewed. 8 references. (auth)

47168 (CNM-R-2(Vol.1), pp 594-609) INTERRELATING ASPECTS OF THE EVOLUTIONARY DEVELOPMENT OF LARGE SCALE DIGITAL COMPUTERS AND NUCLEAR POWER REACTORS. Minton, George H. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Plant Div.).

A review of digital computer development during 1957 to 1967 is presented. The use of digital computers in power reactor design is described. 5 references. (auth)

47169 (GA-9440) PUBLIC SERVICE COMPANY OF COLORADO 330-MW(E) HIGH-TEMPERATURE GAS-COOLED REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Quarterly Progress Report for the Period Ending June 30, 1969. (Gulf General Atomic, Inc., San Diego, Calif.). July 31, 1969. Contract AT(04-3)-633. 233p. Dep. CFSTI.

BLOWERS—disk catcher in Fort St. Vrain Power Reactor Unit 1 helium, analysis of testing of
BOILERS—flow stability of Fort St. Vrain Power Reactor Unit 1, testing of steam-water
FISSION PRODUCTS—distribution of RISO and TRISO coated particle type fuel, effects of coating thickness and fabrication on
FORT ST. VRAIN POWER REACTOR, UNIT 1—pressure vessel for, testing of thermal insulation for prestressed concrete
—remote viewing equipment for, testing of
—remote handling equipment for, testing of shutdown vacuum
—fuel cycle for, analysis of optimum 4 year and 6 year
—core performance for, calculation of optimum
—blower for, testing of disk catcher in
—control rod driver for, description of design modifications for
GRAPHITE—radiation effects on swelling of, measurement of fast neutron
HELIUM—flow distribution in Fort St. Vrain Power Reactor Unit 1 control rod holes, calculation of
NEUTRONS, FAST—effects on swelling of graphite
—effects on physical properties of TRISO coated thorium carbide (ThC_2)-uranium carbide (UC_2) particle type fuel
PRESSURE VESSELS—thermal insulation for Fort St. Vrain Power Reactor Unit 1 prestressed concrete, testing of barrier type
REACTOR CONTROL ELEMENTS—driver for Fort St. Vrain Power Reactor Unit 1, description of design modifications for
REACTOR FUELS—cycle for Fort St. Vrain Power Reactor Unit 1, analysis of optimum 4 year and 6 year
—radiation effects on physical properties of TRISO coated thorium carbide (ThC_2)-uranium carbide (UC_2) particle type, analysis of fast neutron
—fabrication of TRISO coated particle type, quality control in
REACTOR LOADING MACHINES—testing of Fort St. Vrain Power Reactor Unit 1, preparation program for
REMOTE-HANDLING EQUIPMENT—testing of shutdown vacuum, for Fort St. Vrain Power Reactor Unit 1
REMOTE-VIEWING EQUIPMENT—testing of Fort St. Vrain Power Reactor Unit 1
STEAM—H_2O-steam, flow stability in Fort St. Vrain Power Reactor Unit 1 boiler
THERMAL INSULATION—testing of barrier type, for Fort St. Vrain Power Reactor Unit 1 prestressed concrete pressure vessel
THORIUM CARBIDES—ThC_2-UC_2, radiation effects on TRISO coated particle type, analysis of fast neutron
URANIUM CARBIDES—ThC_2-UC_2, radiation effects on TRISO coated particle type, analysis of fast neutron
WATER—H_2O-steam, flow stability in Fort St. Vrain Power Reactor Unit 1 boiler (D.C.C.)

47170 (ORNL-4396) MOLTEN-SALT REACTOR PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING FEBRUARY 28, 1969. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 307p. Dep. CFSTI.

Topics investigated in the molten salt reactor program include: MSRE operations and development; MSBR design and development; chemistry; molten salt irradiation experiments; materials development; and molten salt processing and preparation. Separate abstracts are included for 5 of the 6 sections of the report. (D.C.C.)

For abstracts of individual sections see: 45182, 45369, 45984, 47171, and 47212.

47171 (ORNL-4396, pp 48-128) MSBR DESIGN AND DEVELOPMENT. (Oak Ridge National Lab., Tenn.).

BERYLLIUM FLUORIDES—BeF_2-LiF-ThF_4-UF_4, heat transfer properties of
—BeF_2-LiF-ThF_4-UF_4, thermophysical properties of
CUTTING TOOLS—equipment for pipe, testing of automatic
LITHIUM FLUORIDES—BeF_2-LiF-ThF_4-UF_4, heat transfer properties of
—BeF_2-LiF-ThF_4-UF_4, thermophysical properties of
MOLTEN SALT BREEDER EXPERIMENT—design parameters for
—physics measurements for
MOLTEN SALT BREEDER REACTOR—design parameters for conceptual 1000 MW(e)
—design characteristics for conceptual one fluid 1000 MW(e), analysis of optimum
—off-gas system for, flow diagram and design characteristics of
—boiler for, test stand configuration and flow diagram of
—pumps for, effects of salt characteristics on
—control system for conceptual 1000 MW(e), design requirements for
—fuel salt for conceptual 1000 MW(e), heat transfer and thermophysical properties of
THORIUM FLUORIDES ThF_4—BeF_2-LiF-ThF_4-UF_4, heat transfer properties of
—BeF_2-LiF-ThF_4-UF_4, thermophysical properties of
URANIUM FLUORIDES UF_4—BeF_2-LiF-ThF_4-UF_4, heat transfer properties of
—BeF_2-LiF-ThF_4-UF_4, thermophysical properties of
WELDING—equipment for pipe, testing of automatic (D.C.C.)

47172 THE STAND TO BE TAKEN BY INDUSTRIES FOR THE DEVELOPMENT OF ATOMIC POWER. Doko, Toshio (Tokyo Shibaura Electric Co.). Denryoku Shinpo, 15: No. 4, 16-20(Apr. 1969). (In Japanese).

The development of atomic power generation is achieved only by the mobilization of high-level technologies of all industries. Japan, with its accumulated technology and manpower resources in this field, is capable of establishing its own atomic industry and extending it to the export industry. Japan is largely dependent on imported fuels and at the same time has the problem of industrial public nuisance; the atomic power generation is advantageous in this respect. As an essential for the realization of atomic power generation, understanding of the public for radioactivity must be obtained. Various components of atomic power-generation plants, including the plant itself, pressure vessel and instruments, will be promising items for industrial manufacture and export in Japan. The following in this connection are described: Japan's own de-

velopment of power reactors; understanding and cooperation by the public, as required; atomic-power development as the over-all industrial efforts; the atomic industry promise for exports; standardization in the atomic-power facilities. (NSA of Japan)

47173 UNITED KINGDOM FAST REACTOR APPROVED. Bull. Belgicatom, 12: 3-6(1967).

A Prototype Fast Reactor will be built at Dounreay, Scotland, at a cost including the associated fuel production plant at Windscale, Cumberland, of about £30 million. With a design output of 250 MW(e) and 600 MW(t) the prototype fast reactor will demonstrate operating characteristics of large stations and will irradiate fuel at the heat ratings and temperatures desirable for economic power production. Production of electric power should begin in the first half of 1971. The materials of construction have been chosen to allow the plant to operate at advanced steam conditions of 1050°F, 2300 psi. The fuel will be a mixture of Pu and natural U oxide clad in stainless steel. The fuel will be arranged as small pins grouped in hexagonal bundles, each bundle being charged and discharged as a single unit. The core of the reactor, which is 3 ft high by about 5 ft 6 in. dia, produces 600 Mw of heat. The heat is removed by liquid Na flowing upward through the core. This Na, consisting of 1000 tons, is circulated through the core and the intermediate heat exchangers by 3 mechanical pumps of 18,000 gpm. A secondary coolant loop avoids the problem of accommodating leaks of steam into an active Na system. Advantages of this layout are the high thermal inertia invested in the large volume of primary Na and safety in handling fuel. An important engineering feature is the single-walled steam generator. (BBB)

47174 PRODUCTION OF NUCLEAR ENERGY. Weckesser, A. (Geschaeftsfuehrer der Kernkraftwerk RWE-Bayernwerk GmbH, Gundremmingen, Ger.). Brennst.-Waerme-Kraft, 21: 181-3(Apr. 1969). (In German).

The nuclear power stations in operation or under construction in the Federal Republic of Germany are described briefly. The availability of nuclear energy and its economic competitiveness is evaluated. Fuel supplies and breeder development are outlined. (J.S.R.)

47175 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. De Paravicini, Thomas Pitt (to United Kingdom Atomic Energy Authority). British Patent 1,161,883. Aug. 20, 1969. Filed Nov. 29, 1965.

The reactor system described includes a heat exchanger in which steam is generated from feedwater by heat exchange with the reactor coolant, a high pressure turbine in which the steam is expanded, and a steam driven jet pump circulator for circulating coolant through the reactor core, the circulator being driven by exhaust steam from the high pressure turbine. The reactor may be steam cooled and a proportion of the coolant expanded in a low pressure turbine. The exhaust steam from the high pressure turbine may also be directed into the reactor core coolant channels for reheat, entering the channels through the circulator. Details are given of a power plant employing such a system. (UK)

47176 MAIN PROBLEMS IN DESIGNING A LARGE FAST POWER REACTOR. Leipunskii, A. I.; Orlov, V. V.; Pinkhasik, M. S.; Troyanov, M. F.; Rineiskii, A. A. (Physical-Energetic Inst., Obninsk, USSR). Kernenergie, 12: 225-30(July 1969). (In German).

The most important characteristics of a large fast power reactor effecting its doubling time and economics are as follows: fuel burnup, capital investments for the nuclear power plant, reloading interval, coolant temperature ensuring acceptable thermal efficiency, breeding ratio and specific power, and fuel cycle cost. The choice of basic physical and thermodynamic characteristics of the reactor, its principal components, and the nuclear power plant as a whole are considered taking into account the features above. In particular, such problems as the choice of core power density, the fuel element construction, the core shape and the coolant temperature are discussed. Different engineering solutions of the primary coolant system are analyzed. The choice of the number of heat removal loops, the type and parameters of the steam system, and the basic equipment construction (main circulation pumps, heat exchange equipment, steam generators) are discussed. 17 references. (auth)

47177 DESIGN PHYSICS OF LARGE FAST REACTORS. Novozhilov, A. I.; Troyanov, M. F.; Bobrov, S. B.; Rakitin, I. D.; Zizin, M. N. (Obninsk Inst. of Physics and Power Engineering, USSR). Kernenergie, 12: 230-41(July 1969). (In Russian).

Some results of design studies on the physics of large Na-cooled fast reactors are presented. The methods of improving the physical and economical characteristics of fast reactors due to core and power distribution flattening by different means are considered. The results of preliminary studies of characteristics of a 1000 MW(e) fast breeder reactor with oxide and carbide fuel are included when the two following methods of two-zone power distribution flattening were used: by zone of different enrichment and by zones of different composition (due to different quantity of fuel pins of the same diameter in the fuel assemblies of central and outer core regions). 11 references. (auth)

47178 NUCLEAR REACTORS. Ebeling, Douglas Roy (to United Kingdom Atomic Energy Authority). British Patent 1,162,593. Aug. 27, 1969. Filed June 28, 1967.

Reference is made to light water cooled steam generating reactors employing natural uranium fuel housed in pressure tubes through which two-phase coolant is conducted. In such a system it is desirable to keep the quantity of light water coolant to a minimum for neutron economy reasons. Such a reactor has a positive void coefficient, so that in addition to increasing the burn-up life of the fuel the system described affords a ready means of control. The fuel is housed in vertical tubes, and is provided with an outer sleeve, forming inner and outer channels within the tubes. The inner channel conducts coolant flow through the tubes while the outer channel is open to coolant flow at one end and closed at the other end, the latter end being provided with means for injecting pressurized gas to expel coolant through the open end. By expelling coolant from the channels neutron loss to coolant is reduced, and burn-up and reactivity are increased. The system described is also applicable to reactors employing enriched fuel, which normally have a negative void coefficient. The fuel for each tube is conveniently arranged in cluster form. The clusters have a rectilinear cross-section, and the sleeve is shaped substantially complementary to that of the cluster so as to form segmented voids founded by the tube and the sleeve. The pressurized gas for expelling the coolant is preferably steam, but non-condensible gases could be used. The sleeve may be made expansible by vertically extending corrugations. (UK)

47179 POWER GENERATION. Smith, K. (Central Electricity Generating Board, London). J. Iron Steel Inst. (London), 207: 1202-7(Sept. 1969).

The next decade in power generation will probably see an increasing emphasis on nuclear power stations with a reduced commitment on fossil-fuel-fired stations. The present CEGB standard steam conditions of 2300 lb/in.^{2} and 1000° and 1050°F, are unlikely to be changed radically, except if water reactor stations are built. The general effect will be to modify the requirements of the existing steel products rather than demand entirely new steels or technologies; in particular, increasing emphasis will be placed on the integrity of the product produced. As it is expected also that increasing effort will be applied to reduce overall costs in this capital-intensive industry, it will be necessary for judgment to be made of the correct balance between the requirements of low cost and increased technical integrity. (auth)

47180 THE HTR: NOW AND IN THE FUTURE. Quick, M. (Nuclear Power Group, Knutsford, Eng.). Nucl. Eng. Int., 14: 731-5(Sept. 1969).

The advantages of a UO_2 fueled high temperature gas-cooled reactor are summarised. Parameters are given and there are descriptions of the fuel, the core and restraint system, boilers, circulators, pressure vessel and turbine. Brief attention is paid to the helium plant, control and instrumentation, and to the advantages of downward flow in the core. Future developments of the fuel and on the use of gas turbines are considered. (UK)

47181 BALANCED APPROACH TO REACTOR RESEARCH. Johnson, Wilfrid E. (Atomic Energy Commission, Washington, D. C.). Power Eng., 73: No. 9, 38-41(Sept. 1969).

The fossil fuel supply and projected power growth factors which indicate that nuclear power must play a major role in meeting the expanding electric energy needs are discussed. The time factors involved in the demand for fast breeders are examined, and the development potential of sodium-cooled and gas-cooled fast breeders is discussed. Technical and economic aspects of sodium-cooled reactor development are analyzed, and the potential of high temperature gas cooled breeders, light water breeders, and molten salt breeders is examined. (H.D.R.)

Kinetics and Dynamics

Refer also to abstract 47249.

47182 (ANL-7520(Pt.2), pp 99-109) PARAMETRIC STUDIES LEADING TO THE NUCLEAR CHARACTERISTICS OF THE JAERI

DESIGN STUDIES. Terasawa, S.; Nozawa, M.; Iwaki, T.; Takahashi, J.; Shiozuka, H.; Fujita, M. (Japan Atomic Energy Research Inst., Tokai. Tokai Research Establishment).

The calculation of design parameters for two conceptual 1000 MW(e) liquid Na-cooled fast breeder reactors in Japan is described. Optimum parameters for the first design concept include: critical mass, breeding ratio, internal breeding ratio, Doppler characteristics, Na-void coefficient, and power peaking factor. The parameters for the second design are based on safety. 11 references. (D.C.C.)

47183 (CNM-R-2(Vol.3), pp 1371-83) DTF-BURN: AN ITERATIVE ONE-DIMENSIONAL MULTIGROUP TRANSPORT THEORY BURNUP PROGRAM. Prabulos, J. J. Jr. (Los Alamos Scientific Lab., N. Mex.).

The DTF-BURN computer program is a multigroup transport burnup program designed especially for life history analysis of Pu-fueled fast reactors. For each specified burnup time interval, the program computes the neutron flux distribution. The DTF-BURN program is written in FORTRAN 4 for the IBM 7030. 3 references. (auth)

47184 (ZJE-48) COMPUTATION OF RESONANCE ABSORPTION IN SIMPLE TRANSPORT APPROACH IN HWGCR CLUSTER LATTICE CELL. Stech, S. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). June 1969. 21p. Dep. CFSTI.

The inadequate supposition in resonance integral calculations is usually the "flat-flux" approximation. A method is described in which the neutron flux over the fuel element is expressed by the P-1 transport approach. The Fortran computer program for calculation of cell resonance parameters for A-series reactors is described. (auth)

47185 ACCURATE DELAYED-NEUTRON PARAMETER MEASUREMENTS IN A HEAVY-WATER REACTOR. Graham III, W. W. (Georgia Inst. of Tech., Atlanta); Harmer, D. S.; Cohn, C. E. Nucl. Sci. Eng., 38: 33-41(Oct. 1969).

The familiar rod-drop method for determining delayed-neutron parameters has been refined with new techniques of data collection, analysis, and correction. Values for a highly enriched U, heavy-water reactor have been obtained which have a general applicability because they have been accurately corrected for reactor power history, post-shutdown sub-critical neutron multiplication, and finite rod-drop time. Neutron flux after shutdown by rod drop in the Georgia Tech Research Reactor was monitored for periods in excess of three days using two detectors operated in parallel. One detector used a thermal-neutron-sensitive scintillator, the other a fission chamber. Flux-decay data were fit by weighted least squares using the Variable Metric Minimization method. This method was able to fit all the data simultaneously without limit on the number of fitting parameters. The most statistically-significant fit was obtained with 13 delayed-neutron groups, one of which was attributed to background due to its negligibly small decay constant. A fitting expression was used which accurately described the data collection process in which each data point was taken as the time integral of the flux over a finite time interval. The results are compared with values which have been obtained by small irradiated U samples and with decay-constant values in the last reported heavy-water in-reactor determination. There are indications that delayed-neutron effectiveness is enhanced by ~3% in this type of reactor and that the effectiveness of photoneutron groups is decreased by ~28% because of attenuation of high-energy γ rays. 15 references. (auth)

Control Systems

47186 (APED-5446) CONTROL ROD VELOCITY LIMITER. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Feb. 1967. 27p. Dep. CFSTI.

A detailed description of the design for the control rod velocity limiter for boiling water (BWR) power reactors is given. This control feature is designed as an additional engineered safeguard for BWRs. The requirements and development of the velocity limiter are outlined. Model tests and sensitivity of performance are discussed. Prototype testing is described; results are shown graphically. (M.L.S.)

47187 (APED-5555) IMPACT TESTING ON COLLET ASSEMBLY FOR CONTROL ROD DRIVE MECHANISM 7RDB144A. Benecki, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Nov. 1967. 31p. Dep. CFSTI.

The ability of the collet locking mechanism to prevent a rapid rod withdrawal has been demonstrated by a series of five drop tests. A 310 pound test load was dropped from various heights to produce impact velocities up to 15 feet per second. The test collets sustained significant damage, but they limited downward travel to a maximum of $\frac{3}{4}$-inch after initial impact. Static loads were applied to three collets after the drop tests. The collets accepted a minimum of 7000 pounds with corresponding deflections up to 0.32-inch before the load began to drop off. The maximum calculated drop velocity at impact with the collet is 10 feet per second, and the maximum calculated static load following impact is 4860 pounds. Test data are included. (auth)

47188 (APED-5703) DESIGN AND ANALYSIS OF CONTROL ROD DRIVE REACTOR VESSEL PENETRATIONS. Kobsa, I. R.; Wetzel, V. R. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Nov. 1968. 31p. Dep. CFSTI.

A description of the control rod drive (CRD) penetrations for a large boiling water power reactor pressure vessel is given. Design features are summarized. Sketches show penetration fabrication sequence and stub-tube installation. Design bases for the CRD are described. Methods for stress analyses of CRD penetrations are discussed; probability of design load and ultimate capability are calculated. Results of calculations are tabulated. Calculated and experimentally-determined values for design cycles for axisymmetric socket nozzle connections are compared. Effects of residual stresses are considered. (M.L.S.)

47189 (NYO-3986-1(Vol.1)) PHASE I. NEW PROTECTIVE SYSTEM DESIGN TECHNIQUES FOR APPLICATION IN NUCLEAR REACTOR PLANTS. VOLUME I. Schultz, M. A.; Geisler, G. C. (Pennsylvania State Univ., University Park. Dept. of Nuclear Engineering). Mar. 31, 1969. Contract AT(30-1)-3986. 64p. Dep. CFSTI.

The results of a search of the aerospace literature for concepts which could prove useful in reactor protective systems are presented. The unclassified literature in this area was scanned, and from several hundred thousand items approximately 3000 were selected for further investigation. Over 200 items were selected for detailed study. An analysis and commentary resulting from this study is given. Also for purposes of comparison, a discussion of current design techniques in nuclear protective systems is presented. Using the results of the literature search, a block diagram of a hypothetical reactor protection system is presented, as it might appear if produced by aerospace technology. Four active channels are used to monitor each plant parameter. The four channels are interconnected by voting elements between each major block in the series connected channels. Thus, any fault in a circuit or voter is cleared when the next voter is reached. Numerous faults can occur before the ability of the system to respond to an abnormal condition is jeopardized, or an unnecessary "scram" signal is produced. To ensure continued integrity of the system over the life of the plant, periodic testing is required. This is done by computer scanning of several hundred static system parameters. No active checking circuits are used, and no circuit interruptions are made to inject test signals. A salient feature of the system philosophy is that a complete "fifth" channel is maintained on the shelf for prompt insertion to eliminate any fault discovered. This eliminates the need for hasty, and often inadequate, repairs. (auth)

47190 IMPROVEMENTS IN OR RELATING TO THE CONTROL OF NUCLEAR REACTORS. Gratton, Charles Peter; Stamford, Stanley; Terry, James Bernard (to United Kingdom Atomic Energy Authority). British Patent 1,162,642. Aug. 27, 1969. Filed Dec. 13, 1965.

A nuclear reactor system is described having a core comprised of fuel-containing zones and fuel-free zones with water/steam at supercritical pressure as coolant. The fuel-free zones are bounded by absorber material having neutron capture characteristics predominantly in the thermal energy region. The zones communicate with means for supplying water/steam at supercritical pressure in order to thermalise neutrons in the fuel-free zones to energy levels at which they can be absorbed by the absorber material. The term neutron absorbing material is used in a wider sense than usual and includes material not selected for high capture cross-section but for mechanical properties, such as stainless steel used structurally in the core, or for its fertile properties. Such reactor systems can be controlled by varying the amount of moderator in the core to soften the spectrum and cause higher neutron absorption in the structural material. (UK)

Cooling Systems

Refer also to abstracts 45235, 45570–45573, 45583, 46032, and 46033.

47191 (ANL-7520(Pt.1), pp 213-21) SODIUM SAMPLING AND ANALYTICAL EXPERIENCE AT EBR-II. Miles, C. C.; Ebersole, E. R.; Olson, W. H. (Argonne National Lab., Idaho Falls, Idaho).

The equipment and procedures used in extrusion-vessel sampling and aliquoting of Experimental Breeder Reactor-II sodium coolant are described. Methods used to determine the extent to which impurities segregate in sodium are discussed, specifically in relation to carbon analysis. Typical sodium analysis data obtained on EBR-II coolant samples are presented. (H.D.R.)

47192 (ANL-7520(Pt.1), pp 222-6) IMPURITIES IN EBR-II SODIUM AND COVER-GAS. Olson, W. H.; Miles, C. C.; Cissel, D. W. (Argonne National Lab., Idaho Falls, Idaho).

The operating history of the Experimental Breeder Reactor-II cold trap is summarized. Impurity levels determined in the primary Na, especially Cu, Sn, and Bi, are presented. H_2, O_2, and N_2 levels in the cover gas are listed. (H.D.R.)

47193 (ANL-7520(Pt.1), pp 527-33) THE DISTRIBUTION OF FISSION PRODUCTS IN LMFBR SODIUM SYSTEMS. Zwetzig, G. B.; Guon, J.; Silberberg, M. (Atomics International, Canoga Park, Calif.).

Data on fission product depletion in the Sodium Reactor Experiment primary system following shutdown are tabulated and possible explanations for the depletion mechanisms are discussed. Studies on the distribution and behavior of fission and corrosion products in sodium are summarized, and current studies in the Fission Product Behavior Loop and in the development of a computer analysis method are described. (H.D.R.)

47194 (ANL-7520(Pt.1), pp 549-54) VAPORIZATION OF FISSION PRODUCTS FROM SODIUM. Pollock, B. D.; Silberberg, M.; Koontz, R. L. (Atomics International, Canoga Park, Calif.).

Results of analytical and transpiration apparatus studies on the relative volatility of two fission products, Cs and I_2, in the Na coolant of a LMFBR are presented. The calculational and experimental methods used are described, and the distribution coefficients for fission product vaporization from Na are compared. (H.D.R.)

47195 (GEAP-5724) BWR PRIMARY PIPING STRESSES FOR SYSTEM RELIABILITY ANALYSIS. English, W. F.; Gilman, J. D. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Sept. 1968. Contract AT(04-3)-189. 121p. Dep. CFSTI.

The results of a detailed stress analysis of a typical BWR primary piping system are presented for use in determining the system reliability during its design lifetime. Stresses resulting from normal and abnormal conditions are calculated, and analytical models are discussed. Results are tabulated for each piping component in the system. (auth)

47196 (GEAP-10024) REACTOR PRIMARY COOLANT SYSTEM RUPTURE STUDY. Quarterly Progress Report No. 16, January-March 1969. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1969. Contract AT(04-3)-189. 88p. Dep. CFSTI.

CHROMIUM ALLOYS AND SYSTEMS—Cr-Mo-steel, crack growth in pipes and plates of, effects of stress and temperature on low cycle fatigue
MOLYBDENUM ALLOYS AND SYSTEMS—Cr-Mo-steel, crack growth in pipes and plates of, effects of stress and temperature on low cycle fatigue
PIPES—crack growth in metal, Monte Carlo analysis of through-wall low cycle fatigue
—stress analysis in metal, errors in PAPA-EPS computer program for
—crack growth in ASTM A-106B steel seamless, effects of bending and pressure stresses on
STAINLESS STEEL—crack growth in pipes and plates of Type 304, effects of stress and temperature on low cycle fatigue
STEEL—crack growth in seamless pipes of ASTM A-106B, effects of bending and pressure stresses on
—crack growth in pipes and plates of ASTM A-106B, effects of stress and temperature on low cycle fatigue
—Cr-Mo-steel, crack growth in pipes and plates of, effects of stress and temperature on low cycle fatigue
—crack growth in ASTM A-212B, effects of temperature on low cycle fatigue (D.C.C.)

47197 (HSSTP-TR-1) EVALUATION OF PERIODIC PROOF TESTING AND WARM PRESTRESSING PROCEDURES FOR NUCLEAR REACTOR VESSELS. Heavy Section Steel Technology Program Technical Report No. 1. Yukawa, S. (General Electric Co., Schenectady, N. Y. Materials and Processes Lab.). July 1, 1969. Subcontract 3016. 106p. Dep. CFSTI.

The merits and limitations of these procedures as they might be applied to enhance the fracture reliability of the current generation of light water moderated reactor pressure vessels are reviewed and critically assessed. Positive beneficial effects for warm prestressing have been demonstrated in a number of laboratory tests and in principle, this technique should have considerable value in enhancing the fracture capability of nuclear vessels. However, there are some indications that the beneficial effects may degrade under actual vessel operational conditions such as with prolonged thermal and/or radiation exposure. Until such effects are better understood, the value of warm prestressing is necessarily limited and cannot be completely depended upon. Proof testing procedures and limitations are described. Both procedures are useful only to the extent that the stressing conditions imposed match the operational stresses in both sense and magnitude. Instances where this may not apply are discussed. 68 references. (auth)

47198 NUCLEAR REACTOR CONTAINING JET PUMPS. Arai, Toshiharu (to Hitachi Ltd.). Japanese Patent 1969-12360. June 4, 1969. Filed Sept. 30, 1966.

The BWR-type reactor described includes the following: a pressure vessel; a reactor core; a shroud enclosing the core; jet pumps between the vessel wall and the shroud; and a coolant inlet and a coolant outlet on the pressure-vessel wall. The method has the advantages of elimination of the usual coolant up-flow pipes, increase of usable space within the pressure vessel, elimination of the jet-pump vibration, and improved thermal shielding. A ring-shaped plate is installed between the pressure-vessel wall and the shroud at the shroud-bottom level. A cylinder is then set within the space between the pressure-vessel wall and the shroud; the upper-end circumference is fixed inside the vessel wall a little below the top level of the shroud, and the lower-end circumference is fixed onto the ring-shaped plate. Jet pumps are installed on the cylinder, and their diffusers open through the ring-shaped plate. Coolant water through the inlet on the pressure-vessel wall is distributed in the outer portion of the space between the vessel wall and the shroud. (NSA of Japan)

47199 ANALYSIS OF REGENERATION IN NUCLEAR STEAM POWER PLANTS. Roma, Carlo (Univ., Rome). Ric. Sci., 38: 1326-32(Dec. 1968). (In Italian).

A method for the analysis of the exit temperature of water from agitators is given, with special reference to saturated steam nuclear power plants. The method allows an approximate calculation of the conditions for the optimized thermal cycle. (auth)

47200 PRESTRESSED CONCRETE VESSELS FOR NUCLEAR REACTORS. Gruhl, H.; Dorner, H. Beton Strahlbetonbau, 64: No. 1, 1-10(1969). (In German).

A review of the current state of development of prestressed concrete pressure vessels for nuclear reactors is presented. Noteworthy features of recent designs are considered, including the use of prefabricated high-grade concrete units. A table lists 9 major reactors with details of concrete pressure vessels construction. (UKAEA Info. Bull.)

Fuels

Refer also to abstract 46149.

47201 (AECL-3371) ROLE OF TURBULENCE IN THE VIBRATION OF REACTOR FUEL ELEMENTS IN LIQUID FLOW. Gorman, D. J. (Atomic Energy of Canada Ltd., Chalk River (Ontario)). May 1969. 43p. Dep. CFSTI (U. S. Sales Only).

Results of an experimental and theoretical investigation of the role of turbulence in sustaining reactor fuel element vibration in liquid flow are reported. The properties of the test specimen were similar to those of fuel elements intended for use in the BWR reactor. In the theoretical model it is proposed that the vibrations are random in nature and are caused by random pressure fluctuations in the turbulent boundary layer surrounding the test element. Results of the investigation indicate that in addition to vibration caused by turbulence there is some vibration caused by motion of the fuel element end supports. It is shown that fairly good agreement between experiment and theory is achieved. 13 references. (auth)

47202 (CNM-R-2(Vol.3), pp 1713-36) PHYSICS OF GRAPHITE LATTICES WITH PLUTONIUM BEARING FUELS. Cogne, F.; Laponche, B.; Meyer-Heine, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

Studies on fuel burnup in power reactors are described. Experimental results for burnup characteristics of Pu bearing fuels in graphite lattices are presented. 6 references. (auth)

47203 REFUELLING FOR HTR'S. Wheeler, D. J. (English Electric Co., Whetstone, Eng.). Nucl. Eng. Int., 14: 744-6(Sept. 1969).

Problems associated with the replacement of both fuel and moderator are considered. The preferred core embodiment and properties appertaining to its replacement are outlined. The refuelling plant, handling tool, and fuelling machine are described. Other aspects considered are in-core cooling, the adoption of either single or multi block refuelling, and the development of mechanisms for operation in helium. (UK)

Auxiliary and Emergency Systems

Refer also to abstract 45454.

47204 ELECTRICAL NETWORK AND PROPOSED GUIDELINES FOR A 600 MW NUCLEAR POWER PLANT. Muehleck, B. (Siemens AG, Erlangen, Ger.). Atomwirt., Atomtech., 14: 252-7(May 1969). (In German).

Design parameters are given for the electric generators, black transformers, auxiliary supply transformers, startup transformers, generator leakage control, emergency power supply, motors, and lead-in cables for use in a 600 MW(e) nuclear power plant. Schematic diagrams are included. (J.M.J.)

47205 FUELLING MACHINES FOR NUCLEAR REACTORS. Guild, James Carrie (to United Kingdom Atomic Energy Authority). British Patent 1,161,662. Aug. 20, 1969. Filed Jan. 11, 1966.

Reference is made to loading machines for water cooled reactors of the type with fuel elements housed in vertical channels penetrating the reactor core and with access only at the upper end of the channels for insertion or withdrawal of fuel elements. During operation fuel elements may be damaged so that their lengths may be increased and they cannot be accommodated in the fuelling machine in the normal manner, or fragments of the fuel elements may be left in the channel thereby obstructing loading of new fuel elements. The provision of an inspection window in the loading machine chamber is not feasible since the coolant which passes into the chamber is opaque. The loading machine is provided with an electrical device for sensing the position of a fuel element in the chamber; this device operates by means of variable inductance to give a signal displayed on an external indicator. The sensing device preferably comprises a movable member sealably penetrating the chamber wall and arranged so that when this member is moved to sense the position of a fuel element it is resiliently deformed to avoid damage to the fuel element. The movable member may comprise a spindle which penetrates the chamber wall and which has a cracked arm within the chamber. The spindle is rotatable from a position where the cranked arm lies in a plane normal to the longitudinal axis of the chamber (thereby permitting movement of a fuel element along the longitudinal axis) to a plane parallel with the longitudinal axis. (UK)

47206 SEALING IN PRESSURE OF THE MEASURING LEAD-WIRE IN A REACTOR. Satomi, Masahiro (to Hitachi Ltd.). Japanese Patent 1969-13444. June 17, 1969. Filed July 21, 1964.

In a BWR reactor, a detector is placed within a pressure vessel, and a lead-wire connected to this detector runs up and is taken out through a top lid. By the method proposed, this penetration through the lid can be sealed perfectly, and out-flow of high-pressure steam and water is prevented. Furthermore, breakage of the detector is discovered instantaneously. Where the lead-wire is taken out, an upright cylinder, which opens into the pressure vessel, is fixed onto the top lid of the pressure vessel; the lead-wire from the in-pile detector runs through this cylinder. The upper part of this cylinder is filled with a stack of teflon discs with a central hole for the lead wire to run through. The part below the teflon discs is filled with glass fibers. When the detector in the pressure vessel is destroyed, reactor water is absorbed in the glass fibers, and the fibers are made electrically conductive. When the detector is in normal operation, the glass fibers serve as insulating material. (NSA of Japan)

Operation and Economics

47207 (ANL-7520(Pt.2), pp 24-38) OPERATING EXPERIENCE WITH EBR-II. Deegan, G. E.; Kirn, F. S.; Lawroski, H.; Neidner, R. (Argonne National Lab., Idaho Falls, Idaho).

A review of the operating experiences and required maintenance for the EBR-2 during 1968 is presented. The experimental programs for the EBR-2 are described. 10 references. (D.C.C.)

47208 (APED-5450) DESIGN PROVISIONS FOR IN-SERVICE INSPECTION. Brandt, F. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1967. 19p. Dep. CFSTI.

Requirements of in-service inspection of boiling water power reactors are delineated. Access requirements for visual, ultrasonic, radiographic, and magnetic particle and liquid penetrant inspection are tabulated. Inspection requirements for the various reactor systems and components are listed; design provisions for inspection are described. (M.L.S.)

47209 (CNM-R-2(Vol.1), pp 18-33) CANADIAN DEVELOPMENTS IN NUCLEAR POWER. Gray, J. L. (Atomic Energy of Canada Ltd., Chalk River (Ontario)).

A review of NRX, NRU, and WR-1 operations is presented. The development and operation of power reactors are also described. Fuel and materials development are reviewed. (auth)

47210 (CNM-R-2(Vol.1), pp 34-45) FRENCH NUCLEAR PROGRAM. Horowitz, J. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

A review of the development of power reactors in France is presented. Predictions of power demands and operation economics for power reactors are analyzed. (auth)

47211 (CNM-R-2(Vol.1), pp 58-69) THE NATIONAL NUCLEAR POWER PROGRAMME OF THE UNITED KINGDOM. Kronberger, H. (United Kingdom Atomic Energy Authority, Risley (England). Reactor Group).

The development of power reactors in U. K. is reviewed. The review covers Magnox-type and AGR-type reactors. Predicted thermal and fast reactor development is described. (D.C.C.)

47212 (ORNL-4396, pp 1-47) MOLTEN-SALT REACTOR EXPERIMENT. (Oak Ridge National Lab., Tenn.).

CRITICALITY STUDIES—power tests for uranium-233 fueled Molten Salt Reactor Experiment, analysis of zero
FLANGES—thermal cycle testing of Molten Salt Reactor Experiment prototype freeze
MOLTEN SALT REACTOR EXPERIMENT—operations experience during September 1968 to February 1969
—criticality of, zero power tests for uranium-233
—control rods of uranium-233 fueled, calibration of
—fuel salt of, analysis of gas buildup in uranium-233
—noise in uranium-233 fueled, analysis of neutron and pressure
—loading equipment for uranium-233 fueled, operation procedures for
—fuel sampler-enricher in, operation of
—components in, thermal cycle history of
—freeze flange for, thermal cycle tests on prototype
—control systems performance during September 1968 to February 1969
—instrumentation systems performance during September 1968 to February 1969
REACTOR CONTROL ELEMENTS—calibration of uranium-233 fueled Molten Salt Reactor Experiment
REACTOR COOLING MACHINES—operation procedures for uranium-233 fueled Molten Salt Reactor Experiment
(D.C.C.)

47213 NUCLEAR POWER PLANTS AND THEIR OPERATIONAL CHARACTERISTICS. Numminen, K. Sahko, No. 10, 243-8(Oct. 1968). (In Finnish).

The techniques applied in a nuclear power plant are closely related to those used in a conventional thermal power plant; operation is only automated to a higher degree and the maintenance is handicapped by the fact that several items of equipment are accessible only under controlled conditions. In addition to the reactor proper, new technology is applied to the handling of radioactive waste. Different reactor concepts have some effect on the plant characteristics, but generally one may say that while a nuclear power station is not so easily adaptable to annual and daily load fluctuations as a thermal power plant, it surpasses a high-pressure plant in short-term regulation. (UKAEA Info. Bull.)

47214 TECHNICAL AND ECONOMIC PROBLEMS OF FUTURE DEVELOPMENT OF POWER REACTORS. Seetzen, J. Energ. Tech., 20: 271-4(Sept. 1968). (In German).

It is estimated that about 30 to 40% of all electrical energy requirements in Germany by 1980 will be produced by nuclear reactors in units of 600 to 1200 MW. The economics of various fuels is discussed in great detail and figures of 0.3 Pf/kWh for fast breeders and 0.7 Pf/kWh for light water reactors are quoted compared with 1.3 Pf/kWh for conventional fuel. (UKAEA Info. Bull.)

Safety and Siting

Refer also to abstracts 45484 and 47244.

47215 (ANL-7520(Pt.1), pp 12-16) SODIUM BOILING IN FAST REACTORS. A REVIEW WITH REFERENCE TO THE ISPRA CONFERENCE. Smidt, D. (Kernforschungszentrum, Karlsruhe (West Germany)).

The Conference on Fast Reactor Safety held at Ispra on October 10-11, 1967, is reviewed. Specific papers relating to the possibilities and consequences of sodium boiling in fast reactor cores are discussed. (H.D.R.)

47216 (ANL-7520(Pt.1), pp 195-205) CHARACTERIZATION OF SODIUM POOL FIRES. Johnson, R. P.; Silberberg, M.; Hopenfeld, J.; Beiriger, P. (Atomics International, Canoga Park, Calif.).

The results of tests conducted in the large sodium fires modeling apparatus are given, along with a description of the system. The array of sodium oxide plating and fallout-sampling devices and temperature, pressure, and heat-flux transducers installed in the test vessel is discussed. The sodium burning rate was obtained by determining the overall oxygen concentration within the test vessel. The results demonstrated the ability of the apparatus for studying LMFBR sodium fire accidents on an engineering scale. (J.C.W.)

47217 (ANL-7520(Pt.1), pp 555-61) BEHAVIOR OF SEVERAL FISSION PRODUCTS IN THE ATMOSPHERE SURROUNDING SODIUM-COOLED REACTORS IN THE EVENT OF A MAJOR ACCIDENT. Descamps, Cl. (Societe Belge pour l'Industrie Nucleaire, Brussels); Beaudet, C.; Rygaert, J. (Societe d'Etudes, de Recherches et d'Applications pour l'Industrie, Brussels (Belgium)).

Results of experimental studies on the behavior of fission product aerosols formed during the oxidation of Na at high temperature in contact with molten irradiated UO_2 are presented. Data are listed on the sodium and fission product content in the aerosols following the explosion and on the fission product content in the containment vessel gases following UO_2 melting without Na. (H.D.R.)

47218 (ANL-7520(Pt.2), pp 67-76) SAFETY CONSIDERATION IN SETTING THE DESIGN CRITERIA ON THE JAERI DESIGN STUDIES. Iwaki, T.; Nozawa, M.; Takahashi, J.; Terasawa, S.; Shiozuka, H.; Fujita, M. (Japan Atomic Energy Research Inst., Tokai, Tokai Research Establishment).

Two conceptual designs are presented for the development of liquid Na-cooled fast reactors in Japan. The design criteria safety considerations for each concept are compared. (D.C.C.)

47219 (APED-5448) ANALYSIS METHODS OF HYPOTHETICAL SUPER-PROMPT CRITICAL REACTIVITY TRANSIENTS IN LARGE POWER REACTORS. Wood, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Apr. 1968. 21p. Dep. CFSTI.

Methods for analysis of hypothetical boiling water reactor accidents are described. Mathematical models are given for analysis of Doppler effect, moderator heating, fuel movement, and fuel dispersal. Spatial effects and effects of uncertainties in data are considered. (M.L.S.)

47220 (APED-5454) METAL-WATER REACTIONS: EFFECTS ON CORE COOLING AND CONTAINMENT. Ianni, P. W. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Mar. 1968. 42p. Dep. CFSTI.

The role of metal-water reactions in the evaluation of reactor loss-of-coolant accidents is discussed. It is shown that the amount of metal-water reaction expected to accompany a BWR loss-of-coolant accident is insignificant even if only one of the two core cooling systems provided functions. To support these calculations, results of tests conducted on Zircaloy and inductively-heated Zircaloy rods are summarized. The inherent capability of the pressure suppression containment to accommodate postulated metal-water reactions is far in excess of the amount calculated regardless of the assumptions made concerning hydrogen burning. It is concluded that even though the metal-water reaction phenomenon must be considered in emergency core cooling system sizing, the integrated metal-water reaction occurring is not an overriding consideration in loss-of-coolant accidents. 9 references. (auth)

47221 (APED-5455) MECHANICAL EFFECTS OF REACTIVITY TRANSIENTS. Dieterich, R. A. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Jan. 1968. 40p. Dep. CFSTI.

The physical mechanisms involved in reactivity transients in boiling water power reactors are analysed. Fuel-energy distributions following various reactivity transients are discussed; fuel-to-water energy transfer rates are calculated. The conversion of heat to mechanical energy is discussed. Results of detailed calculations are shown graphically. 8 references. (M.L.S.)

47222 (APED-5528) NUCLEAR EXCURSION TECHNOLOGY. Brammer, H. A.; McWhorter, R. J.; Wood, J. E. (General Electric Co., San Jose, Calif. Atomic Power Equipment Dept.). Sept. 1, 1965; Revised Aug. 1967. 42p. Dep. CFSTI.

A phenomenological description and classification of boiling water power reactor excursions are given; excursion characteristics are tabulated. Effects of reactivity insertion rates are detailed; typical control rod strengths are tabulated. Control rod withdrawal patterns are discussed; rod worth distributions are considered. 8 references. (M.L.S.)

47223 (CNM-R-2(Vol.2), pp 664-80) PARET: PROGRAM FOR THE ANALYSIS OF REACTOR TRANSIENTS. Obenchain, C. F. (Phillips Petroleum Co., Idaho Falls, Idaho. Atomic Energy Div.).

A knowledge of certain processes which occur in small cores is used to predict the course of nondestructive reactivity accidents. The computer program PARET was developed to provide a comprehensive method for making such predictions. The reactor model assumed in PARET consists of a water cooled core represented by an arbitrary number of fuel elements and associated moderator channels, up to a maximum of four. The analysis is based on an evaluation of the coupled thermal, hydrodynamic, and nuclear effects in the core. The PARET code is described, and comparisons between experiment and calculations are presented. 16 references. (H.D.R.)

47224 (CNM-R-2(Vol.2), pp 682-708) TRANSIENT TEMPERATURE CALCULATIONS USING A HYBRID COMPUTER. Bryant, Lawrence T.; Amiot, Lawrence W.; Dickerman, Charles E.; Stephany, William P. (Argonne National Lab., Ill.).

A detailed description is given of a hybrid computer program for calculating temperatures in a multiregion, axisymmetric, cylindrical configuration consisting of solid materials bounded by flowing coolant. Included is an explanation of the mathematical methods together with a discussion of special features, input-output descriptions, and several sample problems. 11 references. (auth)

47225 FUNDAMENTAL DESIGN OF AN ECONOMIC MODEL FOR OPTIMIZING THE DISTRIBUTION OF SITES OF NUCLEAR POWER PLANTS TAKING INTO ACCOUNT THE STRUCTURAL DEVELOPMENT OF MAINS SYSTEM. Gerisch, G. (Technische Hochschule, Dresden). Kernenergie, 12: 241-4(July 1969). (In German).

The fundamental design of an economic model for the optimization of the distribution of sites of nuclear power plants is described. All power plants, the transmission systems of the interconnection, and the territorially distributed load are incorporated in the optimization. The main function and the secondary conditions are formulated mathematically for a multi-year model. (auth)

47226 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stamford, Stanley; Terry, James Bernard; May, William Charles (to United Kingdom Atomic Energy Authority). British Patent 1,162,641. Aug. 27, 1969. Filed Dec. 13, 1965.

Reference is made to a fast acting emergency coolant spray system for cooling a reactor core in the event of coolant system failure. The system is pressurized so that, in normal reactor operation, the reactor pressure inhibits the flow of emergency coolant but on failure of the reactor pressure the resulting pressure differential causes an increased flow of emergency coolant. A control may also be provided whereby the pressure of the emergency coolant may be raised to a level such that there is a controlled outflow of emergency coolant into the reactor. A reactor coolant injection system may also be provided for inject-

ing a spray of coolant into the reactor core whereby the system pressure is approximately equal to the reactor operating pressure during normal reactor operation, the reactor pressure restricting the flow of coolant into the core to an insignificant amount, so that either a decrease of reactor pressure or an increase of system pressure is effective to increase the rate of flow of coolant into the reactor core. Several alternative circuit systems and designs of fuel sub-assemblies are described. (UK)

Power Conversion Systems

47227 (ANL–7520(Pt.1), pp 515-26) STATUS OF SODIUM COMPONENTS TECHNOLOGY IN ITALY. Fogagnolo, G.; Pierantoni, F.; Tarantini, A. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)).

The development of straight tube and helical-tube-bundle intermediate heat exchangers is discussed. The two designs have a capacity of 182 MWt. Supportive work for the heat exchanger designs include sodium-water reaction experiments and the construction of a 1-MW sodium-water loop which has begun. The purpose and characteristics of the facility are given. Steam generator designs include straight-tube-bundle, helical-coiled tube-bundle, and coiled-tube-bundle steam generators. These have capacities of 153 and 306 MWt. The helicoidal-tube reheater has a capacity of 29 MWt. Operational criteria and schematics of the components are given. A schematic of a 50 MWt Sodium Component Test Installation is included. This installation is an oil- or gas-fired test station with the capability of testing the prototypes of intermediate heat exchangers and steam generators in a sodium system. (J.C.W.)

47228 (ANL–7520(Pt.2), pp 147-53) THE SODIUM–CO_2 FAST BREEDER REACTOR CONCEPT. Van Dievoet, J. P. (Societe Belge pour l'Industrie Nucleaire, Brussels).

The compatibility of CO_2 and liquid Na is investigated for use in secondary and primary coolant loops of a liquid Na-cooled fast breeder power reactor. Flow diagrams for a liquid Na and CO_2 heat transfer system are included. Gas-turbine cycles using CO_2 are analyzed. Economics for a liquid Na-cooled fast breeder reactor with a CO_2 secondary system are discussed. (D.C.C.)

Research and Test Reactors

Refer also to abstracts 45439, 45501, 45576, 46087, 47150, 47209, 47327, and 47339.

47229 (AEC-tr–7084) THE PEC REACTOR. Aiello, Paolo; Zona, Rinaldo. Translated from Com. Naz. Energ. Nucl., Notiz., 14: 150-79(1968). 82p. Dep. CFSTI.

Design parameters for the 140 MW(t) PEC Fast Test Reactor are presented. A review of the development program is included. Components are described and illustrated. Physics measurements are listed. (D.C.C.)

47230 (AECL–3188) THE MEASUREMENT OF SPECIFIC HEAT, VISCOSITY, AND DENSITY OF ORGANIC LIQUID REACTOR COOLANTS AT ELEVATED TEMPERATURES. Stewart, R. B.; Smith, G. G. (Atomic Energy of Canada Ltd., Pinawa (Manitoba). Whiteshell Nuclear Research Establishment). Feb. 1969. 29p. Dep. CFSTI (U. S. Sales Only). CAN $1.00.

Methods are described for the determination of specific heat, viscosity and density of organic reactor coolants. They are in current use at the Whiteshell Nuclear Research Establishment for the measurement of the heat transfer characteristics of the WR-1 reactor coolant at temperatures up to 400°C. Specific heat is measured by differential scanning calorimetry with an accuracy of 0.01 cal/g. Viscosity is measured by capillary flow and is precise to 0.01 centistokes. Density is measured by dilatometry, with an accuracy of better than 0.005 g/cm^3. The methods are applicable to other organic liquid mixtures. (13 references) (auth)

47231 (AI-AEC–12855) DIFFERENTIAL NEUTRON SPECTRA IN ECEL REACTOR CORES 17 AND 17P. Paschall, R. K.; Tuttle, R. J. (Atomics International, Canoga Park, Calif.). July 15, 1969. Contract AT(04-3)-701. 28p. Dep. CFSTI.

Differential neutron energy spectra were measured in the central test region of ECEL reactor Cores 17 and 17P. The ECEL reactor has a fast central test region driven by an outer thermal region. The Core 17 test region is composed of ^{235}U, ^{238}U, C, Na, Al, and stainless steel, and had a median fission energy of 93 keV. Core 17P was formed from Core 17 by replacing the plate material in a central subzone by pin-type fuel elements. Each fuel element contained a square array of 49 pins ($^{238}UO_2$ pellets and stacks of 35 wt % fully enriched U in Al disks) with NaF between them; the median fission energy was 69 keV in Core 17P. Spherical proton-recoil detectors filled with H_2 and/or methane were used to measure the spectra. In Core 17, the spectrum at the center of the test region was measured in two ways: the detectors were located at or near the center of the test region, and the detectors were outside of the reactor, measuring the spectrum of a neutron beam emanating from the core center through an empty central drawer in one half of the reactor. In Core 17P, spectra were measured with detectors at the center of the test region as well as at 2-in. intervals along a radius out to 14 in. (slightly into the driver region of the core). The measurements are compared to calculated spectra. Also, the similarities and differences between the two cores are discussed. 13 references. (auth)

47232 (ANL–7520(Pt.2), pp 269-90) PEC: STATUS OF THE DESIGN BEFORE CONSTRUCTION. Aiello, P.; Fogagnolo, G.; Pierantoni, F.; Zona, R. (Comitato Nazionale per l'Energia Nucleare, Bologna (Italy)).

Design characteristics and parameters for the PEC Fast Test Reactor are presented. (D.C.C.)

47233 (BNWL–1150) REACTOR PHYSICS QUARTERLY REPORT, APRIL–JUNE 1969. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). Aug. 1969. Contract AT(45-1)-1830. 114p. Dep. CFSTI.

CRITICALITY STUDIES —measurement of poisoned and unmoderated plutonium oxide (PuO_2) assemblies
—measurement of unreflected and water reflected plutonium oxide (PuO_2)-uranium oxide (UO_2) spherical assemblies, effects of plutonium oxide (PuO_2) composition on
FAST TEST REACTOR —fuel management scheme for, calculation of optimum
—core of, coolant flow rate calculations for optimum
FLUID FLOW (TURBULENT) —calculations of optimum FTR core
PLUTONIUM RECYCLE TEST REACTOR —physics measurements of, comparison of multigroup cross section codes and reactor codes for
—fuel burnup calculations for, errors in computer codes
REACTORS —physics studies on, digital computer programs for
REACTORS, FAST —physics studies from April to June 1969 on, summary of
REACTORS, THERMAL —physics studies from April to June 1969 on, summary of (D.C.C.)

47234 (CEA-CONF–1321) MEASUREMENTS OF SOME PHYSICAL PARAMETERS RELATED TO RAPSODIE'S IRRADIATIONS EXPERIMENTS. Gourdon, J.; Besoux, M. (Commissariat a l'Energie Atomique, Cadarache (France). Centre d'Etudes Nucleaires); De Goer, J. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires). [1968]. 29p. (CONF-690427–1). Dep. CFSTI (U. S. Sales Only).

Physics measurements for irradiation experiments in Cadarache Reactors (Rapsodie) are presented. Techniques required to obtain the measurements are described. The measurements include: fission rates; subassembly outlet temperatures; γ-heating; and dosimetry. (6 references) (D.C.C.)

47235 (CNM-R-2(Vol.1)) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE UTILIZATION OF RESEARCH REACTORS AND REACTOR MATHEMATICS AND COMPUTATION, MEXICO, MAY 2–4, 1967. (Comision Nacional de Energia Nuclear, Mexico City. Centro Nuclear de Mexico). 609p. (In English and Spanish). (CONF-670501-(Vol.1)). Dep.

Thirty two papers presented at the conference are included. Separate abstracts were prepared for 25 papers. One paper (Computers; Past, Present, and Future) was not abstracted. The remaining 6 papers were previously abstracted for NSA and appeared as: 21: 22070, 21: 23478, 21: 25739, 21: 25634, 23: 7412, and 23: 13541. (M.C.G.)

For abstracts of individual papers see: 45221, 45303, 45304, 45479, 46092, 47166–47168, 47209–47211, 47236–47243, and 47292–47297.

47236 (CNM-R-2(Vol.1), pp 94-100) USE OF A RESEARCH REACTOR IN THE NATIONAL NUCLEAR PROGRAM. Brunson, G. S. (International Atomic Energy Agency, Vienna (Austria)).

Services and responsibilities related to research reactors that are performed by the International Atomic Energy Agency are described. (D.C.C.)

47237 (CNM-R-2(Vol.1), pp 310-18) BANDSAW: A PROPOSAL FOR REMEASURING DELAYED NEUTRON ENERGIES, YIELDS, AND HALF LIVES IN AFSR-TYPE REACTORS. Brunson, G. S.; Huber, R. J. (Argonne National Lab., Idaho Falls, Idaho).

An approach to the problem of delayed neutron yield, period, and energy measurements is presented. The use of a "long foil" sample in the form of an endless tape passing band saw fashion through the "glory hole" of a AFSR-type reactor is described. Results are presented. 10 references. (auth)

47238 (CNM-R-2(Vol.1), pp 390-407) INSTALLATION, EVALUATION AND INITIAL UTILIZATION OF THE PENN STATE TRIGA REACTOR. Geisler, George C.; Kenney, Edward S.; Ross, Donald A. (Pennsylvania State Univ., University Park).

Conversion procedures for the Pennsylvania State University Triga Mark 3 research reactor are presented. Startup and testing programs of the converted facility are described. Utilization schedules for the reactor are listed. 2 references. (D.C.C.)

47239 (CNM-R-2(Vol.1), pp 408-49) PULSTAR: SLIGHTLY ENRICHED URANIUM-DIOXIDE FUELED REACTOR. Hall, W. F.; Lumb, R. F. (Western New York Nuclear Research Center, Inc., Buffalo); MacPhee, J. (T. I. United States Ltd., Stamford, Conn.).

The design, testing, and operating experience of PULSTAR, a combination pulse 2000 MW and steady state 2 MW reactor, are discussed. The reactor core is fueled with UO_2 pellets, enriched to 6%, clad in Zircaloy 2 tubing, and is controlled by flat Cd-In-Ag blades. 5 references. (auth)

47240 (CNM-R-2(Vol.1), pp 450-87) KINETIC BEHAVIOR OF TRIGA REACTORS. West, G. B.; Whittemore, W. L.; Shoptaugh, J. R. Jr.; Dee, J. B.; Coffer, C. O. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

A review is presented of recent experimental work related to the Advanced TRIGA Prototype Reactor (ATPR) program. Comparisons of calculated and experimental design characteristics for pulse performance are described. 23 references. (auth)

47241 (CNM-R-2(Vol.1), pp 488-508) REACTIVITY CALCULATIONS FOR A PERIODICALLY PULSED FAST REACTOR BY THE TIMOC CODE. Rief, H.; Kschwendt, H.; Jaarsma, R. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The Monte Carlo program which has been developed to three-dimensional reflectivity worth problems, is called TIMOC. It deals with all common nuclear phenomena and scattering laws while the energy dependency of nuclear parameters is taken into account by multigroup cross sections. By using many variance reducing techniques, the program calculates, among other quantities, the effective multiplication factor, the mean generation time and neutron spectra at different points of interest. A special perturbation method is used to calculate the reactivity worth of a specified region. This method has been used mainly to study reactivity changes caused by the passage of the moving reflector, the removal of control or safety mechanisms and other processes which produce small changes in the reactor composition. One of the exchangeable geometry subroutines allows the almost exact mock-up of the pulsed reactor SORA, especially of its moving reflector and the control and safety mechanisms. 15 references. (auth)

47242 (CNM-R-2(Vol.1), pp 538-72) DESIGN OF A HIGH-PERFORMANCE UO_2 PULSE REACTOR. Kazi, A. Halim; Tomonto, James R.; Teer, Bill R. (United Nuclear Corp., Elmsford, N. Y. Research and Engineering Center).

The physics measurements are presented for a conceptual water-moderated pulsed reactor design study based on high-performance UO_2 fuel elements. 19 references. (auth)

47243 (CNM-R-2(Vol.1), pp 573-93) PULSED AND MODULATED NEUTRON EXPERIMENTS IN UNIVERSITY OF FLORIDA NUCLEAR ASSEMBLIES. Uhrig, Robert E.; Butterfield, L. D.; Cockrell, R. G.; Ohanian, M. J.; Perez, Rafael B. (Florida Univ., Gainesville. Dept of Nuclear Engineering Sciences).

Neutron die-away pulsing experiments performed in the University of Florida Training Reactor are described. Results are compared with theoretical calculations. 20 references. (D.C.C.)

47244 (CNM-R-2(Vol.2)) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE UTILIZATION OF RESEARCH REACTORS AND REACTOR MATHEMATICS AND COMPUTATION, MEXICO, MAY 2-4, 1967. (Comision Nacional de Energia Nuclear, Mexico City. Centro Nuclear de Mexico). 566p. (In English and Spanish). (CONF-670501-(Vol.2)). Dep.

Separate abstracts were prepared on 23 of the papers in this section of the conference. The other six papers have appeared previously in NSA as abstracts 21: 25714, 21: 25720, 21: 27664, 21: 29334, 21: 40521, and 23: 7413. (E.R.B.)

For abstracts of individual papers see: 45534, 45609, 45947, 47223, 47224, 47245-47248, 47288, and 47298-47310.

47245 (CNM-R-2(Vol.2), pp 709-25) FLOW INVERSION TRANSIENT ASSOCIATED WITH A LOSS OF PRIMARY PUMP POWER. Emon, D. E. (Texas Agricultural and Mechanical Univ., College Station).

The computer program DEMON for analysis of the flow inversion transient associated with a loss of primary pump power in a plate type research reactor is described. Results are presented for six different hot channel calculations with variations in coolant loop coastdown time, shutdown reactivity, friction head, and convection head. 5 references. (H.D.R.)

47246 (CNM-R-2(Vol.2), pp 841-52) TANGENTIAL BEAM PORT FOR CAPTURE GAMMA RAY EXPERIMENTS. Johnson, W. Reed; Spessard, R. Lee (Virginia Univ., Charlottesville. Dept. of Nuclear Engineering).

A tangential beam port was built and installed at the University of Virginia reactor to provide an intense beam of capture gamma radiation. The port was relatively inexpensive and its installation did not necessitate interruption of the normal operation of the reactor. The addition of this facility has significantly increased the research potential of the reactor system, and since it has become available the utilization factor of the reactor has increased by about a factor of four. Another tangential port is being designed which will not "view" the reactor reflector at all and will therefore eliminate most of the background problem. 9 references. (auth)

47247 (CNM-R-2(Vol.2), pp 899-908) OUT-OF-PILE FISSIONING UTILIZING A NEUTRON BEAM FROM A RESEARCH REACTOR. Sabo, Julius Jay (National Center for Radiological Health, Rockville, Md.); Duffey, Dick (Maryland Univ., College Park).

A method for providing a source of recently formed fission products representative of those released by incipient fuel failure is described. An assembly of natural uranium foil was placed in a University of Maryland reactor beam port outside the concrete biological shield. The beam hole is an aluminum thimble containing air at atmospheric pressure. The fission products were collected on a dust stop filter impregnated with activated carbon and the gamma activity of the filter was scanned. The system description and test results are presented. 5 references. (H.D.R.)

47248 (CNM-R-2(Vol.2), pp 909-26) PRODUCTION OF ISOTOPES BY FAST NEUTRONS IN RESEARCH REACTORS. Courtemanche, R. (Atomic Energy of Canada Ltd., Ottawa (Ontario)).

A method for increasing the fast neutron flux in irradiation capsules is described. The capsules, used for isotope production in a fast flux, are long, hollow cylinders lined with enriched uranium. Descriptions are presented of the capsules, the fast flux in the capsules, and isotope yields from calculations of sample irradiations. 4 references. (H.D.R.)

47249 (CNM-R-2(Vol.3)) PROCEEDINGS OF THE INTERNATIONAL CONFERENCE ON THE UTILIZATION OF RESEARCH REACTORS AND REACTOR MATHEMATICS AND COMPUTATION, MEXICO, MAY 2-4, 1967. (Comision Nacional de Energia Nuclear, Mexico City. Centro Nuclear de Mexico). 557p. (In English and Spanish). (CONF-670501-Vol.3)). Dep.

Thirty four papers presented at the conference are included. Separate abstracts were prepared for 30 papers. Four papers were previously abstracted for NSA and appeared as abstracts 21: 25628, 21: 25713, 21: 30258, and 22: 10077. (M.C.G.)

For abstracts of individual papers see: 46566, 47183, 47202, 47250-47265, 47311-47318, 47332, 47333, and 47340.

47250 (CNM-R-2(Vol.3), pp 1215-29) USES OF RESEARCH REACTORS FOR ACTIVATION ANALYSIS. Guinn, V. P. (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

Modifications and improvements in high flux neutron activation analysis techniques are described for research reactors. Applications for high flux neutron activation analysis are discussed. 13 references. (auth)

47251 (CNM-R-2(Vol.3), pp 1230-6) RESEARCH REACTORS AND INDUSTRIAL APPLICATIONS OF RADIOACTIVITY.

Thomas, Charles C. Jr. (Western New York Nuclear Research Center, Inc., Buffalo).

The industrial utilization of research reactors is discussed with respect to radiation effects studies, production of special tracers, and radioisotope production. 11 references. (auth)

47252 (CNM-R-2(Vol.3), pp 1287-1307) MIT RESEARCH REACTOR UTILIZATION PROGRAM. Barnett, E.; Clark, L. Jr.; Gosnell, J.; Gwinn, D.; Thompson, T. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering).

Design parameters and experimental facilities for the MIT Research Reactor are described. Operation of the reactor is reviewed. Experimental applications are discussed. 10 references. (D.C.C.)

47253 (CNM-R-2(Vol.3), pp 1308-26) REACTOR PHYSICS MEASUREMENTS IN THE ARGONNE FAST SOURCE REACTOR. Amundson, P. I.; Davey, W. G.; Curran, R. N.; Brunson, G. S.; Huber, R. J. (Argonne National Lab., Idaho Falls, Idaho.).

Physics measurements for the Argonne Fast Source Reactor are presented. Experimental programs requiring thermal and fast neutron fluxes are reviewed. 16 references. (D.C.C.)

47254 (CNM-R-2(Vol.3), pp 1327-32) USE OF L-77 10-WATT SOLUTION REACTOR AS A NON-DESTRUCTIVE TOOL FOR CONTROLLING REACTOR COMPONENTS. Koontz, R. L.; Mooers, A. R.; Greenfield, M. A. (Atomics International, Canoga Park, Calif.).

The 10-watt L-77 laboratory solution reactor built by Atomics International was used routinely as a means of determining the distribution and total Sm_2O_3 content of SNAP 8 and 10 A/2 cladding tubes, and as a means of specifying the adequacy of stainless steel and Zr reactor components used in the Hallam Nuclear Power Facility. The technique used to determine the total cross-section of SNAP fuel element cladding, the relative worth of the burnable Sm_2O_3 poison in the coating and the relative amount of the poison per unit area of cladding tube is described. (auth)

47255 (CNM-R-2(Vol.3), pp 1248-55) USE OF RESEARCH REACTORS AT ARGONNE NATIONAL LABORATORY. Martens, F. H. (Argonne National Lab., Ill.).

Applications and operation of the 4 research reactors at the Illinois site of the Argonne National Laboratory are described. The reactors include: CP-5; JANUS; JUGGERNAUT; and ATSR. 29 references. (D.C.C.)

47256 (CNM-R-2(Vol.3), pp 1256-73) RESEARCH PROGRAM OF THE FORD NUCLEAR REACTOR AT THE UNIVERSITY OF MICHIGAN. Kerr, William; Martin, Robert D. (Michigan Univ., Ann Arbor. Michigan Memorial Phoenix Project).

The Ford Nuclear Reactor at The University of Michigan has been integrated into the educational and research programs of the University. The Physics Department uses the reactor for isotope production in the support of nuclear structure studies. The Nuclear Engineering Department utilizes the reactor in support of neutron spectroscopy and radiation effects studies. The Chemistry Department uses the reactor in its activation analysis and radiation chemistry programs. Other departments as well as several other universities and industrial groups utilize the reactor in support of their research programs. This level of utilization has justified continuous operation of the reactor on a seven-day-per-week basis since January, 1966. 32 references. (auth)

47257 (CNM-R-2(Vol.3), pp 1274-86) UTILIZATION OF THE 15 MW RESEARCH REACTOR SILOE. Merchie, F. (Commissariat a l'Energie Atomique, Grenoble (France). Centre d'Etudes Nucleaires).

General characteristics and experimental facilities of the Grenoble Reactors (Siloe) are described. Research and experimental activities performed in Siloe are reviewed. 14 references. (D.C.C.)

47258 (CNM-R-2(Vol.3), pp 1534-47) UNUSUAL PHYSICS PROBLEMS OF BROOKHAVEN'S RESEARCH REACTORS. Chernick, J. (Brookhaven National Lab., Upton, N. Y.).

Design problems and solutions are presented for the BNL Advanced Pulsed Reactor. 21 references. (auth)

47259 (CNM-R-2(Vol.3), pp 1548-59) ELIMINATION OF THE EFFECT OF A CONSTANT NEUTRON SOURCE IN REACTIVITY MEASUREMENTS. Tuttle, R. J. (Atomics International, Canoga Park, Calif.).

Measurements of reactivity in research reactors and critical assemblies frequently must be made at relatively low power levels to avoid the requirements for large radiation shields and cooling systems, and to facilitate accessibility and fuel handling. The presence of a strong constant neutron source in some reactors affects the kinetic behavior to the extent that reactivity measurements are subject to considerable error. This error will be particularly severe for reactors fueled with plutonium having a large fraction of ^{240}Pu, because of neutrons produced by spontaneous fission of this isotope. Additional sources of neutrons are photoneutron production in beryllium or heavy water moderators and alpha-induced reactions in oxygen and other light elements in the fuel material. A technique for accurately correcting for a constant neutron source has been developed using the dynamic reactivity method. This method utilizes a computer to derive instantaneous reactivity from the time behavior of the reactor power. The computed reactivity is the sum of two terms: the true reactivity, and a source effect that is inversely proportional to reactor power. The source effect may be determined by analyzing the variation with power of the computed reactivity following a step reactivity change. The source effect thus determined is then used by the computer program to calculate the instantaneous reactivity, correcting for the source perturbation. 3 references. (auth)

47260 (CNM-R-2(Vol.3), pp 1560-88) MEASUREMENT OF THE TRANSFER FUNCTION IN A MIXED SPECTRUM CRITICAL ASSEMBLY. Madero, Carlos Castro (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.). (In Spanish).

Transfer function measurements in the Mixed Spectrum Critical Assembly are discussed. Use of the transfer function to evaluate the kinetic behavior of reactors with coupled zones is described. Results of measurements are compared with an analytical model used to calculate the kinetic parameters. Experimental procedures and equipment are described briefly. Data are tabulated and shown graphically. 14 references. (M.L.S.)

47261 (CNM-R-2(Vol.3), pp 1611-24) MANAGEMENT OF LOW POWER RESEARCH REACTORS. Kato, W. Y. (Argonne National Lab., Ill.).

A review is presented of the current operating practices of Argonne's zero power reactors which have evolved over many years. It is emphasized that in addition to sound administrative procedures and practices, it is necessary to have well-designed, reliable components and to utilize effectively the careful considered judgment of competent individuals for the safe operation of reactors. 19 references. (auth)

47262 (CNM-R-2(Vol.3), pp 1630-44) NUCLEAR REACTOR CENTER OF MEXICO. Morales Amado, A. (Comision Nacional de Energia Nuclear, Mexico City). (In Spanish).

A brief summary of the utilization of the Nuclear Reactor Center of Mexico is given. Objectives, organization, and future plans are summarized. (M.L.S.)

47263 (CNM-R-2(Vol.3), pp 1645-56) UTILIZATION OF A PULSED REACTOR FOR RESEARCH AND IRRADIATION. Miley, George H. (Illinois Univ., Urbana).

A review of operations and studies performed in the University of Illinois TRIGA Reactor is presented. Pulsed operation experiments and procedures are described. 51 references. (D.C.C.)

47264 (CNM-R-2(Vol.3), pp 1657-83) GAMMA RAY STUDIES WITH THE ISRAEL RESEARCH REACTOR-2. Moreh, R.; Arad, B.; Ben-David, G.; Schlesinger, Y.; Tenenbaum, J. (Israel Atomic Energy Commission, Beersheba. Nuclear Research Center-Negev).

Gamma radiation experiments and studies performed in the 26 MW IRR-2 are described. Topics discussed include: neutron capture γ radiation from various targets; Mossbauer studies; nuclear spectroscopy using resonance scattering of capture γ radiation; and precision studies of highly excited nuclear levels using a γ monochromator. Experimental results are presented. 8 references. (D.C.C.)

47265 (CNM-R-2(Vol.3), pp 1684-1712) EXPERIENCE IN THE OPERATION AND UTILIZATION OF REACTORS. Cosentino, Jorge O. (Comision Nacional de Energia Atomica, Buenos Aires (Argentina)). (In Spanish).

Brief descriptions of the Argentine research reactors are given; cutaways of the reactors are shown. Experience in operating and utilizing the reactors is summarized. (M.L.S.)

47266 (GEAP-10010) SOUTHWEST EXPERIMENTAL FAST OXIDE REACTOR DEVELOPMENT PROGRAM. Quarterly Report No. 20, February-April 1969. Pflasterer, G. R.; Becker, R. A. (comps.) (General Electric Co., Sunnyvale, Calif. Breeder

Reactor Development Operation). May 1969. Contract AT(04-3)-540. 18p. Dep. CFSTI.

Gas-pressure measurement techniques for SEFOR fuel rods are described. Fabrication of SEFOR thermocouple containing fuel rods is also described. The SEFOR startup testing and transient testing programs are reviewed. Operations and construction tasks completed during February to April 1969 are listed. (D.C.C.)

47267 (IAE-1693) HIGH-FLUX STATIONARY RESEARCH REACTORS AND THEIR PROSPECTS. Feinberg, S. M. (Akademiya Nauk SSSR, Moscow. Institut Atomnoi Energii). 1968. 24p. (In Russian). Dep. CFSTI (U. S. Sales Only).

Successful operation of stationary research intermediate-neutron reactors with a thermal-neutron trap is described. The prospects of further enlargement of the neutron flux are discussed. A comparison is made with the design of a fast-neutron accelerator used as the source of an intensive field of thermal neutrons. (10 references) (auth)

47268 (IN-1313) SUBASSEMBLY TEST PROGRAM OUTLINE FOR FY 1969 AND 1970. Grund, J. E.; Johnson, R. L.; Johnson, K. O.; Miller, R. W.; Johnson, R. T.; Norton, B. E. (Idaho Nuclear Corp., Idaho Falls). Aug. 1969. Contract AT-(10-1)-1230. 175p. (IDO-17277). Dep. CFSTI.

The Subassembly Test Program in the Spert IV Capsule Driver Core for FY 1969 and 1970 is outlined. Basic program objective is to provide the AEC and reactor vendors with experimental information on reactor fuel behavior under transient overpower conditions. Test plans for unirradiated and irradiated (burnups to 30,000 MWd/T) UO_2 fuels, Pu recycle fuels, and LMFBR fuels are presented. Data of particular interest include failure modes and thresholds, conversion efficiencies of nuclear-to-mechanical energy, transient pressures, and metal-water reaction extents, all as functions of transient energy deposition for a variety of fuel design parameters, burnup, and environmental conditions. 10 references. (auth)

47269 (KR-136) MEASUREMENT OF THERMAL SPECTRAL INDICES IN REACTOR CELLS NEAR PLANE ABSORBERS. Wennemo-Hanssen, S. E. (Institutt for Atomenergi, Kjeller (Norway)). 1969. 49p. Dep. CFSTI.

Thermal spectrum effects of plane boron-steel absorbers, covering a wide range of optical thicknesses, have been studied in the UO_2/H_2O zero power assembly NORA. An integral spectrum property has been determined in terms of a spectrum index defined by the activation ratio of the isotopes ^{176}Lu and ^{164}Dy. In the experiments the spatial variation of the spectrum index has been measured using a foil technique. The experimental results confirm that the thermal spectrum is considerably hardened near the absorbers. The spectrum transients of the absorbers were found to extend about 1 to 2 pitches into the surrounding lattice. The Monte Carlo code MONTROSA has been used for interpretation of the experimental results. MONTROSA calculates the spatial distribution of the thermal neutron spectrum, based on the Brown-St. John energy transfer model, in unit cells bounded by plane absorbers. From previous investigations within the NORA Project, one knows that the BSJ model predicts too soft spectra compared to experiments. The spectral indices computed by MONTROSA have therefore been corrected according to calculations by K-7 THERMOS using the Koppel-Young scattering model. Taking into account also a correction in the epithermal results due to foil perturbation effects in moderator, the experimental and the calculated spectral indices are in good agreement in nearly all cases. The only case where a smaller discrepancy seems to occur is in moderator very close to a 5.7 mm thick absorber. Here the calculated spectrum is slightly too soft compared to experiment. 13 references. (auth)

47270 (SRARI-P-19) DEVELOPMENT OF THE METHODS AND RECORDING APPARATUS FOR THE EXPERIMENTAL DETERMINATION OF THE ENERGY RELEASE IN THE CHANNELS OF HIGH-FLUX RESEARCH REACTORS. Neverov, V. A.; Samsonov, B. V.; Tsykanov, V. A. (Scientific Research Atomic Reactor Inst., Melekess (USSR)). 1968. 106p. (In Russian). Dep. CFSTI (U. S. Sales Only).

The description of new calorimetric device construction and recording systems of sample temperature change and reactor power in time is reported. The method analysis of some known and newly developed calorimetric methods of energy-release measurement in reactor channels is shown. The exact estimate of measurement errors has been obtained for a number of known methods on the base of energy release measurement in some channels of SM-2 reactor with help of one calorimetric device. The measurement results of energy release levels in reactor channels are given for different moments after reactor shutdown by safety rod tripping. (auth)

47271 THE USE OF THREE-DIMENSIONAL HETEROGENEOUS ANALYSIS IN SUBSTITUTION EXPERIMENTS WITH A SMALL NUMBER OF FUEL ELEMENTS. Paillon, M. (CCR-EURATOM, Ispra, Italy); Taddei, F. Energ. Nucl. (Milan), 16: 551-6(Sept. 1969).

A three-dimensional heterogeneous analysis is presented of substitution experiments with few elements. The results obtained from the application of this method to substitution experiments with CIRENE fuel elements in ECO are discussed and compared with the results obtained by using homogeneous and two-dimensional heterogeneous methods. 6 references. (auth)

47272 STUDIES IN THE CORE COMPONENTS IN THE GROSSWELZHEIM CRITICAL MOCKUP. Andres, R.; Kilian, P.; Schmidt, U. Atomwirt., Atomtech., 14: 264-6(May 1969). (In German).

The light-water moderated critical assembly in the AEG nuclear energy research installation at Grosswelzheim was installed for the testing of design data and the final control of reactor core components. The critical assembly and typical research programs are described, based on examples of zero-power measurements for the Lingen Power Reactor. The smallest critical core, uniformity measurements on the core components, and the temperature coefficient of reactivity were determined. (tr-auth)

47273 BIOLOGICAL SHIELDING TEST OF KYOTO UNIVERSITY REACTOR. Katsurayama, Kosuke; Ishida, Masahiro; Tsujimoto, Tadashi; Mizuma, Mitsuo. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 203-38(Oct. 1968).

A biological shielding test was carried out as one of the characteristic tests of KUR. From the results of radiation measurements, it was found that when the shutters of beam-tubes, exposure-tubes, through-tube, graphite-moderator, and heavy-water facility were all closed, shielding effects gave lower than permissible dose in the areas other than in the reactor top area and the bottom area, where the basement of the reactor containment and the heavy water facility are situated. (auth)

47274 NEUTRON CRYSTAL MONOCHROMATOR ELIMINATING HIGHER HARMONICS. Shibuya, Iwao; Iwata, Yutaka; Mitani, Shigeshi; Fukui, Susumu; Koyano, Nobumitsu. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 121-36(Oct. 1968).

The special feature of the Kyoto University Reactor monochromator by which higher harmonics are eliminated by using a diffraction after deflection method is described. (H.D.R.)

47275 NEUTRON FLUXES IN THE FACILITY OF MULTI-LAYER MEDIUM. Ono, Masayoshi; Fujita, Yoshiaki; Kanda, Keiji; Shibata, Toshikazu; Okamoto, Sunao. Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 108-20(Oct. 1968).

Presented are the results of the simple two-group analysis of neutron fluxes in multi-layer medium of the heavy water facility attached to the Kyoto University Research Reactor (KUR). The thermal neutron flux distribution derived from this analytical method agrees well with the experimental values. The thermal neutron flux obtained experimentally at 1 MW of reactor power is 5.68×10^8 n/cm^2 sec at the center of the outerface of the facility with the cadmium ratio more than 10^4. (auth)

47276 INITIAL CALIBRATION OF THE KYOTO UNIVERSITY REACTOR. Shibata, Toshikazu; Kawakubo, Tetsuya; Nanjyo, Tsutomu; (and others). Annu. Rep. Res. Reactor Inst., Kyoto Univ., 1: 5-94(Oct. 1968).

Results of measurements made during the KUR initial testing and calibration are presented. Included are: (1) description of the KUR; (2) the critical experiment; (3) control rod worth calibration; (4) reactivity measurements; (5) thermal neutron flux distribution and power calibration; (6) temperature coefficient of reactivity; (7) cooling system tests; (8) neutron flux and gamma dose in experimental facilities; (9) cooling water radioactivity; (10) heavy water testing; and (11) reactor containment tests. (H.D.R.)

47277 EFFECTIVE NEUTRON TEMPERATURE MEASUREMENTS IN A WELL MODERATED REACTOR BY THE REACTIVITY COEFFICIENT METHOD. Raisic, N.; Klinc, T. (Jozef Stefan Inst. of Nuclear Research, Ljubljana, Yugoslavia). Bull. Boris Kidric Inst. Nucl. Sci., 19: Nucl. Eng., No. 4, 31-5(Nov. 1968).

The ratio of the reactivity changes of a nuclear reactor produced by successive introduction of two different neutron ab-

sorbers in the reactor core, has been measured and information on effective neutron temperature at a particular point obtained. Boron was used as a 1/v absorber and cadmium as an absorber sensitive to neutron temperature. Effective neutron temperature distribution has been deduced by moving absorbers across the reactor core and observing the corresponding reactivity changes. (auth)

Rocket and Space Reactors

47278 (SWRHL-60-r) PARTICULATE EFFLUENT STUDY. PHOEBUS 2A: EP-IV AND EP-V. (Public Health Service, Las Vegas, Nev. Southwestern Radiological Health Lab.). June 1969. 62p. Dep. CFSTI.

The Phoebus 2A Experimental Plans IV and V were full-power nuclear reactor operations conducted as part of Project Rover. Large effluent particles of high activity were studied for particle deposition concentration at various distances, gross physical characteristics, chemical composition, and gross and specific radioactivity. Survey results indicated wide spread deposition for Plan IV with no defined hotline. Plan V survey results indicated the major deposition between 13° and 21° from Test Cell C. The particles were porous and fragile and had a metallic black appearance. Sizes ranged from eight to 200 μm on Plan IV and seven to 163 μm on Plan V. The use of a latex spray reduced the shattering of particles during collection and separation. The chemical composition of the particles was primarily uranium oxides. Fall velocity was determined in free air and liquid. Gross activity of the particles was 10^7-10^{11} fissions on both runs. The primary radioisotopes found by gamma spectroscopy were those of Sr, Zr, Ru, I, Ba, Mo, and Ce. (auth)

47279 SUPERSONIC AERODYNAMICS AND ROCKET PROPULSION. Lee, Robert F. Los Angeles, Robert F. Lee, 1963. 200p.

Equations and numerical values relating to the flight of a supersonic vehicle through an atmosphere are presented. The important results of supersonic aerodynamics are presented in a form that will allow the aeronautical engineer to design the vehicle or calculate the aerodynamic forces involved in its flight. Some fundamentals of thermodynamic relationships in supersonic flow are included. Basic rocket performance, liquid propellants, and nuclear rocket propulsion are discussed. (H.D.R.)

47280 FEED SYSTEMS AND NOZZLES FOR PHOEBUS REACTOR EXPERIMENTS. Gunn, S. V.; Dunn, C. (Rocketdyne, Canoga Park, Calif.). J. Spacecraft Rockets, 6: 769-77(July 1969).

In support of the Phoebus 1B and Phoebus 2A reactor experiments, an advanced and unique liquid-hydrogen feed system was designed, developed, and placed in successful operation at Test Cell C, Nuclear Rocket Development Station (NRDS). The system's configuration features two axial-flow liquid-hydrogen pumps, each powered by a five-stage axial-flow turbine, which may be operated singly or in parallel depending upon the flow requirements of the reactor experiment. The turbodrive gases are obtained by diverting a small portion of the pump discharge flow through a hot-water heat exchanger. They are then metered to each turbine by a common turbine control valve in response to an integrated turbopump speed/facility flow demand control system. Liquid-hydrogen bypass valves for each pump discharge duct are integrated into automatically controlled, specific-speed-limit systems to provide control of system discharge impedance under conditions of rapidly changing reactor propellant flow. The system's discharge pressure and flow capabilities range to 2000 psig and 35,000 gal/min. The nozzle requirements of the Phoebus 1 series of reactor experiments were satisfied by modifying and uprating the nozzles employed in the Kiwi reactor experiments. By improving the coolant passage design and by strengthening the reactor shell mounting flange, the operating capabilities of the nozzle were increased to more than satisfy the thermal and radiation-induced heating loads associated with the Phoebus 1 reactor tests. (auth)

47281 MAJOR FACTORS INFLUENCING THE DEVELOPMENT OF A NUCLEAR FLIGHT STAGE. Sandford, J. W.; Dowdy, W. L. (North American Rockwell Corp., Downey, Calif.). J. Spacecraft Rockets, 6: 778-84(July 1969).

The feasibility of solid-core nuclear rocket propulsion systems has been adequately demonstrated by the Rover, Kiwi, and Phoebus programs. With the advanced state of development of the nuclear engine system, it is in order to focus attention on the mission, scientific research, and program aspects influential in the development of a flight stage. In particular, the major technology, design, development, qualification, and operational elements which can affect the performance, economics, and schedule of the nuclear vehicle have been considered. Each phase of the vehicle development cycle is pursued sequentially illustrating the resultant requirements based on and influenced by the decision making rationale associated with specific mission objectives. Additional factors not directly related to but which could influence the overall nuclear vehicle program are specified. (auth)

47282 RADIO-FREQUENCY PLASMA SIMULATION OF GAS-CORE REACTOR. Thorpe, Merle L. (Humphreys Corp., Concord, N. H.). J. Spacecraft Rockets, 6: 923-8(Aug. 1969).

An induction plasma device capable of operating continuously with an input power of 1 MW has been assembled to simulate the NASA-designed gas-core space propulsion reactor. A central core of low-velocity argon gas simulates the uranium fuel of the reactor. The thrust fluid is a high-velocity sheath of hydrogen which is heated by the argon. This simulation is possible because of the unique properties of the induction plasma generation scheme where an rf field can form an ionized argon plasma completely within a hydrogen stream. Operation has been accomplished with H_2/A ratios as large as 50, comparable to the predicted optimum motor design flow criteria. The direct heating of premixed hydrogen-argon mixtures by an induced electric field has been investigated and 1-atm plasma containing up to 70% H_2 has been achieved. Operation of the induction plasma as a radiating source (light bulb) shows reliable capability to 967 kW in a single source with 25% of input power available as usable radiation. 10 references. (auth)

47283 ACOUSTIC INSTABILITIES IN A GASEOUS CORE NUCLEAR ROCKET. McNeill, Harry. Troy, N. Y., Rensselaer Polytechnic Inst., 1968. 112p.

Thesis.

A simplified and idealized physical model in which the fission gas of a gaseous core nuclear rocket is initially uniform, stationary, infinite in the longitudinal direction and bounded by a neutron reflector is studied for instabilities. The effect of the neutron field on system stability is analyzed. The results indicate that the neutron field has a strong damping effect which tends to compensate for the amplification due to the density dependent fission cross-section. The stability analysis was accomplished by using a numerical-graphical method consistent with the uncertainty in fuel opacity data. The dispersion equation for the plasma was derived and solutions for sound wave propagation in the plasma were obtained. The results indicate that the damping from induced electric fields for a singly ionized plasma was negligible in the first order solution obtained. (Disser. Abstr.)

47284 LARGE SPACE STATION POWER SYSTEMS. Boretz, Jonathan E. (TRW Systems, Redondo Beach, Calif.). J. Spacecraft Rockets, 6: 929-36(Aug. 1969).

Various candidate electric power systems were investigated for use in the 1980 to 1985 period with a nine-man, one- to two-year, space station requiring an average power level of 20 kW(e). The eleven systems considered fell into three power-source categories, solar, isotope, and nuclear reactor. For the orbital altitude assumed (260 naut miles), the solar-array/secondary-battery system would have the lowest in-earth-orbit cost. However, for missions employing lower orbital altitudes (≤200 naut miles), the drag-make-up propellant weights would become excessively high, and a reactor-thermoelectric system would be recommended. For the 20-kW(e) power range, isotope-heat-source systems would be too costly despite the use of high-efficiency power conversion systems. Isotope availability and safety considerations also present problems. A substantial reduction of payload launching costs would enhance the cost effectiveness of reactor systems most and solar-array/battery systems next; isotope systems would be least affected because isotope costs predominate. 21 references. (auth)

47285 RECENT NERVA TECHNOLOGY DEVELOPMENT. Rice, C. M. (Aerojet-General Corp., Sacramento, Calif.); Arnold, W. H. J. Spacecraft Rockets, 6: 565-9(May 1969).

On December 15, 1967, the NRX-A6 nuclear reactor successfully demonstrated 1-hr, full-power operational capability. It produced 1100 MW of thermal power with a hydrogen flow rate of 72 lb/sec and a chamber temperature of 4150°R. The cumulative reactivity loss at 30 min was an order of magnitude lower than for earlier NRX reactors, and it was nearly linear to 60 min. The program is proceeding toward tests of a complete engine in flight-oriented configuration and under simulated altitude conditions. Two test of a nonfueled assembly demonstrated facility and engine-control-system readiness for XE-1 tests. Features of the facility and the engine control system are discussed briefly. 2 references. (auth)

Process Heat and Desalination Reactors

47286 DESALTED WATER FOR AGRICULTURE. Hammond, R. Philip (Oak Ridge National Lab., Tenn.). Oak Ridge Nat. Lab. Rev., 1: 3-9(Summer 1967).

The present use of the world's land for growing food is reviewed. Water consumption and yields by the three basic food grains—wheat, corn, and rice—are presented. The technical and economic aspects of large nuclear desalting plants for providing water for agriculture are examined, and characteristics of the "food factory" centers created are discussed. (H.D.R.)

47287 BN-350 NUCLEAR POWER PLANT. Leipunskii, A. I.; Afrikantov, I. I.; Orlov, V. V.; (and others) (Physical-Energetic Inst., Obninsk, USSR). Kernenergie, 12: 145-58 (May 1969). (In German).

The nuclear power plant with BN-350-type fast reactor is now under construction in Shevchenko at Mangyshlak peninsula. It will generate 150 MW(e) and produce 120,000 tons/day of fresh water. Thermal power of the reactor is 1000 MW. This reactor is sodium-cooled, sodium flow rate being 14,100 tons/hr. The sodium average outlet temperature equals to 500°C. The plant technological scheme, the construction of the reactor, its assemblies and reloading system are described; some emergency conditions are considered; the data for the experimental substantiation of basic elements of the reactor design are given. The main constructional work is next to completion; the reactor tank manufacture is being finished and the manufacture of main and auxiliary equipment is being carried out. Some systems are already mounted. (auth)

Marine and Portable Power Reactors

47288 (CNM-R-2(Vol.2), pp 726-39) OPTIMUM REACTOR SHIELDING. Enginol, T. B. (Gesellschaft fuer Kernenergieverwertung in Schiffbau und Schiffahrt m.b.H., Geesthacht (West Germany). Institut fuer Reaktorphysik).

A method for optimizing the layer thicknesses of reactor shielding is described. An analytical expression for approximating the layer thicknesses is found and then applied in an iteration procedure. A shielding code is used as a subroutine so that at each iteration step dose attenuation properties of the layers are determined. The optimization program is short and simple, and may be combined with any detailed appropriate shielding code. 4 references. (H.D.R.)

47289 (DOCKET-50238-49) N.S. SAVANNAH. License No. NS-1. Buffer Seal Malfunction. (First Atomic Ship Transport, Inc., New York). Sept. 16, 1969. 2p. Dep. CFSTI.

Procedures involved in correcting water leakage around a control rod of the Maritime Pressurized-Water Reactor are described. Incorrectly located lantern ring and spacer rings allowed buffer seal water to be misguided. (D.C.C.)

47290 NUCLEAR MERCHANT SHIP ECONOMICS: A TWENTY-YEAR FORECAST. Kesterman, Frank. Nav. Eng. J., 81: 113-19(Apr. 1969).

A comparative analysis is presented of the economics of equivalent 30 knot nuclear and fossil fueled containership systems operating between the U. S. East Coast and the Far East and between the U. S. East Coast and Australia. Projections are made to 1984 to estimate the effect of certain conditions and long term trends on nuclear ship economics. The analyses are based on estimates of variations in revenue, fuel oil cost, nuclear fuel costs, reactor plant cost, and subsidy. (H.D.R.)

Production Reactors

47291 (DUN-SA-113) INSTRUMENTATION PERFORMANCE AT N REACTOR. Flickinger, J. K. (Douglas United Nuclear, Inc., Richland, Wash.). [1965]. 9p. (CONF-691004-1). Dep. CFSTI.

From 24th Annual Conference on Instrument Society of America, Houston, Tex.

A brief description of N Reactor's major plant instrumentation systems is presented and a few of the measurement and control problems, origin, and resolution are discussed. Measurement and control of water level in 12 large steam generators, 16 dump condensers, and a large pressurizer vessel are discussed. Sensor problems in measurement of reactor fuel channel outlet coolant temperatures are also discussed. (auth)

Reactor Theory

Refer also to abstracts 46899, 47233, 47235, 47244, and 47249.

47292 (CNM-R-2(Vol.1), pp 176-205) A NEW METHOD OF APPROXIMATION OF THE BOLTZMANN EQUATION. Benoist, P.; Kavenoky, A. (Commissariat a l'Energie Atomique, Saclay (France). Centre d'Etudes Nucleaires).

In a new method of approximation of the Boltzmann equation, one starts from a particular form of the equation which involves only the angular flux at the boundary at the considered medium and where the space variable does not appear explicitly. Expanding in spherical harmonics the angular flux of neutrons leaking from the medium and making no assumption about the angular flux of neutrons leaking from the medium and making no assumption about the angular flux within the medium, very good approximations to several classical plane geometry problems are derived, including: the albedo of slabs and the transmission by slabs, the extrapolation length of the Milne problem, and the spectrum of neutrons reflected by a semi-infinite slowing-down medium. The method may be extended to other geometries. 9 references. (auth)

47293 (CNM-R-2(Vol.1), pp 206-18) DIRECT ITERATIVE SOLUTION OF THE DIRECTED NEUTRON FLUX PROBLEM FOR CRITICAL CONDITIONS. Vondy, D. R. (Oak Ridge National Lab., Tenn.); Stevens, P. N. (Tennessee Univ., Knoxville).

The general problem of effecting a critical system was formulated for digital machine calculation of the directed neutron flux by iteration of the multi-group, finite-difference equations for one-dimensional slab geometry. It was found that in many situations a critical situation could be achieved with little more calculational effort than required for the usual eigenvalue problem. Direct iteration toward a critical system was found to be a practical method of calculation for typical problems encountered in the analysis of nuclear reactors. The technique was also used with Carlson's S_n formulation in one and two dimensional calculations of directed flux. 7 references. (auth)

47294 (CNM-R-2(Vol.1), pp 219-37) THEORETICAL FOUNDATION FOR COARSE MESH VARIATIONAL TECHNIQUES. Froehlich, Reimar (General Dynamics Corp., San Diego, Calif. General Atomic Div.).

A general analysis of the matrix, eigenvalue, and eigenvector properties for the variational coarse mesh equations is presented. Positive properties for the coarse mesh rebalancing and Galeskin operators are described. These properties are helpful in applying Wiebandt iterative methods to the coarse mesh equations, and they provide a theoretical basis for stable direct solution techniques of the inhomogeneous coarse mesh equations. 11 references. (auth)

47295 (CNM-R-2(Vol.1), pp. 238-49) VARIATIONAL DEVELOPMENT OF S_N THEORY. Schreiner, Sheldon; Selengut, D. S. (California Univ., Berkeley).

An alternative derivation of the S_N equations for the one velocity transport problem in plane geometry is described by using a variational approach. This permits retaining the angular segmentation picture of the neutron angular distribution, but leads to an unambiguous result for the entire set of equations as well as the boundary and continuity conditions to be imposed at interfaces. The required variational formalism is outlined. The direct and adjoint angular flux distributions implied by the angular segmentation approximation are used as trial functions, leading to a set of differential equations and boundary conditions which can be interpreted as the analogs of either the Mark or Marshak procedures used in the spherical harmonics approximation. 4 references. (auth)

47296 (CNM-R-2(Vol.1), pp 250-66) GENERALIZED VARIATIONAL PRINCIPLES FOR REACTOR ANALYSIS. Pomraning, G. C. (Brookhaven National Lab., Upton, N. Y.).

Variational principles are compared for derivation and accuracy. The basic ingredient in the derivations is a particular use of Lagrange multipliers. Using the technique of postulating the principles and then proving the accuracy, it is shown that more general variational principles can be established. 10 references. (auth)

47297 (CNM-R-2(Vol.1), pp 267-77) A TECHNIQUE FOR COMPUTING THE INVERSE DIFFERENTIAL CROSS-SECTION TRANSFORMATION MATRIX T^{-1}. Berland, R. F. (Atomics International, Canoga Park, Calif.).

A technique is presented for computing T^{-1} directly, as opposed to the usual method of computing T and then numerically inverting it to obtain T^{-1}. Some numerical examples are given to demonstrate the accuracy attained. 12 references. (auth)

47298 (CNM-R-2(Vol.2), pp 612-50) COMPARATIVE PHYSICS ANALYSIS OF FAST REACTORS AS A FUNCTION OF REFINEMENT IN MULTIGROUP CROSS SECTION PREPARATION. Toppel, B. J.; Hummel, H. H. (Argonne National Lab., Ill.).

The generation of multigroup cross sections for fast reactors for groups having energy widths corresponding to 0.5 lethargy unit is discussed. Almost all the methods discussed are concerned with the use of a fundamental mode flux for collapsing cross sections, as used by the MUFT, GAM, ELMOE, and MC^2 codes. Space-dependent effects in group cross section averaging are discussed briefly. 25 references. (H.D.R.)

47299 (CNM-R-2(Vol.2), pp 927-42) COMPARATIVE ANALYSIS OF PROBLEMS IN NUCLEAR FUEL BURNUP, REACTOR KINETICS AND DYNAMICS AS A FUNCTION OF COMPUTER CAPACITY. Hansen, K. F. (Massachusetts Inst. of Tech., Cambridge. Dept. of Nuclear Engineering).

The direct effects of increased computer capacity on kinetics and burnup calculations are considered. A historical survey of reactor kinetics calculations is presented. A sample problem is defined and a particular solution method is applied to the problem. The time and storage requirements for the problem are estimated, and it is indicated that increases in computer capacity are not enough to fulfill the goal of useful, accurate, and economic calculations of reactor transients. A similar study is presented with regard to burnup calculations. 22 references. (H.D.R.)

47300 (CNM-R-2(Vol.2), pp 943-59) ON THE VALIDITY OF THE POINT KINETICS EQUATIONS. Canosa, Jose (General Electric Co., Pleasanton, Calif. Vallecitos Atomic Lab.).

The validity of the point kinetics approximation to describe a large power excursion caused by a step insertion of reactivity is studied. In one-group diffusion theory, the flux shape used in point kinetics is identical with the steady-state flux of a hypothetical reactor which has the same space-dependent material buckling as that causing the excursion. With this definition, the point kinetics approximation is shown to give quite a good description of the power excursions over a well-defined range, both for homogeneous and for inhomogeneous (two-region) step reactivity insertions. A very simple analytical criterion is presented which gives the range of validity of the point kinetics approximation. 5 references. (auth)

47301 (CNM-R-2(Vol.2), pp 960-82) SOLUTION OF THE MULTI-GROUP SPACE-TIME DIFFUSION EQUATIONS. Poncelet, C. G. (Westinghouse Electric Corp., Pittsburgh, Pa. PWR Plant Div.).

A method of solution of the time-dependent diffusion equations is described. The method is fast and of sufficient generality for large reactor system design and analysis. The method is based on the numerical solution of the Laplace-transformed multigroup time-dependent diffusion equations. The theory and mathematical derivation of the working equations are summarized, and numerical methods of solution are described. The digital computer program SPARTA is outlined. Examples of application of the method in dynamic measurements, spatial stability, and coupled-core kinetics are presented. 16 references. (H.D.R.)

47302 (CNM-R-2(Vol.2), pp 994-1014) A COMPARISON OF SOME NUMERICAL METHODS FOR SOLVING THE EQUATIONS OF REACTOR DYNAMICS. Szeligowski, John; Hetrick, David (Arizona Univ., Tucson).

The numerical solution of the equations of reactor dynamics is frequently complicated by the presence of one response time that is very short compared to the overall time-response of the system (e.g., slow transients in a fast reactor). The number of time steps in a standard method (e.g., Adams, Runge-Kutta) may become prohibitively large. Some computational methods that circumvent this limitation are reviewed and compared. The methods fall into two general classes: those based on expansions in a small parameter, and those using integral equations in which the slowly varying factors in the integrands are approximated by known functional forms. The former, which include the "prompt-jump approximation," may be classified as singular perturbation expansions; these are typically restricted to a limited range of some parameter and hence will fail for a non-stationary system whenever some time-dependent coefficient strays outside a prescribed limit (e.g., a slow ramp reactivity input approaching prompt critical). Integral methods do not have this latter limitation; the methods treated may be classified as iterative, variational, and largest-eigenvalue methods. Some typical examples of slow transients in fast reactors demonstrate reduction of the number of time steps by a factor of the order of 10^5. 19 references. (auth)

47303 (CNM-R-2(Vol.2), pp 1015-30) PULSED NEUTRON ANALYSIS WITHOUT FUNDAMENTAL MODES. Corngold, Noel (Brookhaven National Lab., Upton, N. Y. California Inst. of Tech., Pasadena).

In certain limiting situations in neutron transport theory the variation of a fundamental eigenvalue which transcends the theoretically allowed range is observed. This limiting region is examined for a pulsed neutron experiment in non-multiplying media. The eigenvalues which lie outside the allowed range are studied by the process of analytic continuation. The analysis is based upon the time-dependent initial-value problem. 10 references. (H.D.R.)

47304 (CNM-R-2(Vol.2), pp 1031-46) USE OF THE FLUCTUATION CORRELATION FUNCTION FOR STUDYING THE DYNAMIC CHARACTERISTICS OF REACTORS. Velez, Carlos (Instituto Politecnico Nacional, Mexico City. Escuela Superior de Fisica y Matematicas).

The use of noise analysis methods for the determination of reactor kinetics parameters is reviewed. The application of correlation and autocorrelation functions to fluctuations in both power reactors and pulsed reactors is examined. 9 references. (H.D.R.)

47305 (CNM-R-2(Vol.1), pp 1059-85) THE j_N METHOD FOR TIME-DEPENDENT NEUTRON TRANSPORT PROBLEMS. Asaoka, T. (European Atomic Energy Community, Ispra (Italy). Joint Nuclear Research Center).

The j_N method is a new analytical approach which has emerged in the course of developing a multiple collision theory. The method is characterized by the introduction of a discontinuity factor to fix the point of measurement and by the use of expansions in spherical Bessel functions. When this expansion is truncated beyond the N-th order function, the resulting approximation has been called "the j_N approximation." It has been shown that the method is widely applicable to stationary transport problems for a bare spherical system and an infinite homogeneous slab. A further development of the j_N method to deal with time-dependent problems for a bare sphere and an infinite homogeneous slab is presented. 6 references. (auth)

47306 (CNM-R-2(Vol.2), pp 1086-98) DISCRETE ORDINATES REPRESENTATIONS OF THE SCATTERING KERNEL. O'Reilly, B. D.; Lewis, R. C. (Atomics International, Canoga Park, Calif.).

The adequacy of the discrete ordinates quadrature methods to represent the scattering transfer kernel to determine the angularly dependent energy spectrum in a neutron transport problem for which the maximum energy change per collision is larger than the energy mesh spacing is examined. 10 references. (auth)

47307 (CNM-R-2(Vol.2), pp 1099-1108) MOMENTS MATCHING SPECTRAL METHOD FOR SLAB TRANSPORT PROBLEMS. Robinson, Alan H. (Oregon State Univ., Corvallis).

With a view toward obtaining a simple means of solving transport problems in complex geometries and energy dependent problems, a new method of solving the plane geometry, one-speed transport equation was developed. This method combines Case's eigenfunction expansion of the flux with a moments method to find the expansion coefficients. Thus, the usually difficult feature of Case's method, to find the expansion coefficients, is greatly simplified. This method is applicable to problems in cylindrical and spherical geometry as well as plane geometry problems. As a specific example of the method, the disadvantage factor problem for a two-region slab cell is solved. 9 references. (auth)

47308 (CNM-R-2(Vol.2), pp 1109-20) SAFE: A THREE-DIMENSIONAL MONTE CARLO CODE FOR NUCLEAR SAFETY STUDIES. Levitt, L. B. (Atomics International, Canoga Park, Calif.).

The application of the Monte Carlo code SAFE to determine the criticality constant of a complicated assembly of fuel elements in packaging containers is described. SAFE will compute k_{eff} for an array of containers, each containing an array of fuel elements of arbitrary internal geometry, so long as each container and its contents is identical to the other members of the array. 3 references. (H.D.R.)

47309 (CNM-P-2(Vol.2), pp 1121-35) OPTIMIZED DUAL PERTURBATION TECHNIQUE. Miller, L.; Miley, G. H. (Illinois Univ., Urbana); Gast, P. F. (Argonne National Lab., Ill.).

The AMC code is designed to efficiently solve reactivity perturbation problems. The objective in this type of calculation is to determine the values of integrals of reaction rates over specified regions of space and energy or to find the change in these integrals due to a perturbation of the system. Therefore, some generalities concerning the stochastic evaluation of integrals are considered. These general principles are then applied to the evaluation of integrals of reaction rates. The dual perturbation methods used in the Monte Carlo code, AMC, are described in detail. Some of the details of the AMC code are described. 4 references. (auth)

47310 (CNM-R-2(Vol.2), pp 1136-40) A NEW USE OF ADJOINTS IN THE MONTE CARLO ANALYSIS OF RESONANCE INTEGRAL EXPERIMENTS. Levitt, L. B. (Atomics International, Canoga Park, Calif.).

The Monte Carlo analysis of resonance integral experiments with a small sample in a large moderating region of a reactor requires a sampling of neutron histories which intersect the sample prior to slowing down below the resonance energy region. An adjoint formulation procedure is described for obtaining a source distribution by starting all particle histories incident on the surface of the sample and following backward in configuration space to regions from which they would have been picked in a straightforward Monte Carlo calculation. (H.D.R.)

47311 (CNM-R-2(Vol.3), pp 1333-47) GYMEA: A ZERO DIMENSIONAL BURNUP AND DATA PREPARATION CODE. Robinson, G. S.; Pollard, J. P. (Australian Atomic Energy Commission Research Establishment, Lucas Heights).

The GYMEA computer program is written for neutronic studies of high temperature gas cooled reactors. The program is written in FORTRAN for an IBM 360/50 and IBM 7040. 31 references. (D.C.C.)

47312 (CNM-R-2(Vol.3), pp 1348-67) GENERALIZED FORMULATION FOR FAST REACTOR FUEL CYCLE STUDIES. Meneley, D. A.; Leaf, G. K.; Walker, P. M.; Kyong, S. H. (Argonne National Lab., Ill.).

Details of a few of the techniques developed for model analysis of fast reactor fuel cycles are presented. Simulation of material motions and the solution of the equation set governing fuel transmutations are described. (D.C.C.)

47313 (CNM-R-2(Vol.3), pp 1384-97) CALCULATING PERTURBATIONS OF BURNUP HISTORIES. Vaughan, E. U.; Berland, R. F. (Atomics International, Canoga Park, Calif.).

The application of perturbation theory to the calculation of burnup is analyzed. (auth)

47314 (CNM-R-2(Vol.3), pp 1398-1406) A METHOD FOR SOLVING DIRECTLY FOR THE EXPOSURE DISTRIBUTION AT THE END OF A POWER REACTOR FUEL CYCLE. Macnabb, W. V.; Fischer, D. L. (General Electric Co., San Jose, Calif.).

A method is described for treating the calculation of a fuel cycle by making a simplifying assumption about the fuel exposure at each point in the core while still retaining the detailed geometric effects of fuel loading. The method is most useful in analyzing thermal, water-moderated reactors, such as boiling water reactors. The method uses a "backwards" solution to the neutron diffusion equation to find a final exposure which is distributed in the core in exactly the same way as the power. 4 references. (auth)

47315 (CNM-R-2(Vol.3), pp 1407-27) A NEW APPROACH TO CALCULATION OF FLUX DISTRIBUTIONS IN A REACTOR BASED UPON A FEW MEASURED VALUES. Gast, P. F. (Argonne National Lab., Ill.).

A mathematical model is described for calculating the neutron flux distributions in a reactor based upon a few measured values. The disadvantages and errors in using this type of model analysis are discussed. (auth)

47316 (CNM-R-2(Vol.3), pp 1495-1514) METHOD OF COMPUTING RESONANCE INTEGRALS IN MULTI-REGION REACTOR CELLS. Kier, P. H. (Argonne National Lab., Ill.).

A method is developed for the computation of resonance absorption in multi-composition reactor cells that is based on space and lethargy dependent slowing down sources. As restrictions are not placed on cross section, the method permits resonances in any composition and non-uniform temperature distributions. This method has been used to write a computer code, RABBLE. RABBLE calculations of the hot-cold resonance interaction effect in Doppler measurements are presented. 8 references. (auth)

47317 (CNM-R-2(Vol.3), pp 1515-33) USE OF THE ELMOE-SNARG PROGRAMS TO STUDY DETAILS OF NEUTRON SPECTRA THROUGH REGIONS OF RESONANCE-SCATTERING MEDIA. Meneghetti, D.; Rago, A. L.; Phillips, K. E. (Argonne National Lab., Ill.).

Spatially dependent fine-energy-detailed fluxes through interfaces between essentially purely scattering media are directly calculated. The fine-energy-group cross sections, obtained by use of the ELMOE library of annular scattering data, are employed in the regions of a fine-group spatial-dependent calculation using a modified SNARG. Thus discrete S_N transport solutions may be obtained utilizing the detailed angular distribution data available in the ELMOE program. The position-dependent fine-group solutions are also used to study the position sensitivity and difficulties of obtaining effective coarse-group cross sections using the fine-group solutions for weightings. 7 references. (auth)

47318 (CNM-R-2(Vol.3), pp 1589-1604) IMPULSE RESPONSE MEASUREMENTS USING PSEUDO RANDOM SOURCE EXCITATION. Meyer, Paul (California Univ., Livermore. Lawrence Radiation Lab.).

The usefulness and limitations of the pseudo random source excitation technique as a diagnostic tool in thermal reactors are discussed. Measurements are compared with those obtained by the repetitive pulsed neutron technique. 13 references. (auth)

47319 DETERMINATION AND STUDY OF THE NETWORK OF FUNCTIONS FOR TRANSFER IN A REACTOR. Barbaste, P. Automatisme, 14: 167-72(Apr. 1969). (In French).

The transfer function for a subcritical reactor maintained at constant neutron flux by a source is established. The set of transfer functions for subcritical reactors is studied. Curves obtained are compared with experimental results, by use of a special apparatus constructed for the purpose, using the classical principle of introducing a periodic perturbation of reactivity and comparing gain and phase of the response of the reactor with the signal introduced. Data are calculated for a critical reactor, one subcritical by 1%, and one subcritical by 0.1%; agreements between theory and experiment for the gain curve and the phase curve are excellent. For frequencies above 0.1 Hz the two curves for the subcritical reactor are practically indistinguishable from that of the critical reactor. Models are adapted for several representations of supercritical reactors and for a reactor of constant multiplication coefficient. (BBB)

47320 COMPARISON OF ALTERNATING-DIRECTION TIME-DIFFERENCING METHODS WITH OTHER IMPLICIT METHODS FOR THE SOLUTION OF THE NEUTRON GROUP-DIFFUSION EQUATIONS. Hageman, L. A.; Yasinsky, J. B. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 38: 8-32(Oct. 1969).

Alternating-direction implicit (ADI) time-differencing approximations are developed for the two-dimensional neutron group-diffusion equations. These methods are analyzed for accuracy and stability relative to the implicit-difference approach used in the TWIGL program. It is shown that for model problems (bare homogeneous reactors with constant material properties) the ADI method is as accurate as the TWIGL method and much faster computationally. However, several numerical comparisons show that the ADI approach is asymptotically unstable for non-model problems unless extremely small time-steps are used. Such comparisons show the ADI methods to be inferior to the TWIGL method for realistic reactor-dynamic problems. A variant on the ADI scheme (ADI-B^3) is developed and for a class of delayed supercritical problems shown to be potentially superior to all methods considered. 26 references. (auth)

47321 METHOD OF CORRELATION OF BURNUP MEASUREMENTS FOR PHYSICS PREDICTION OF FAST POWER-REACTOR LIFE. Gandini, A. (Comitato Nazionale per l'Energia Nucleare, Rome). Nucl. Sci. Eng., 38: 1-7(Oct. 1969).

Starting from the generalized perturbation formulations in the neutron field obtained from the importance conservation principle, perturbation expressions for any desired order relevant to measurements in the nuclide field are derived by analogy. Their use is proposed for correlating isotopic analyses of samples irradiated in fast power reactors with the nuclear parameters. In particular, information on capture and fission cross sections of fissile and fertile materials may be obtained and effectively used in a consistency approach. A numerical example is given relevant to first- and second-order perturbation terms, which illustrates the applicability of the method. 12 references. (auth)

47322 SOLUTION OF THE TELEGRAPHER'S EQUATION FOR AN ARBITRARY INFINITE PLANE SOURCE. Niederauer,

George F. (Lewis Research Center, Cleveland). Nucl. Sci. Eng., 38: 70-1(Oct. 1969).

A solution of the telegrapher's equation for an arbitrary infinite plane source is presented. 4 references. (auth)

47323 CALCULATIONAL METHOD FOR THERMAL DISADVANTAGE FACTOR. Buslik, A. J. (Bettis Atomic Power Lab., West Mifflin, Pa.). Nucl. Sci. Eng., 38: 71-7(Oct. 1969).

A method for the calculation of the thermal disadvantage factor is presented. The method includes effects of spectral hardening in the fuel. Comparisons of results to those of the more elaborate multigroup Monte Carlo calculations are made. This Multiple Saver method is a modification of the FSBK method and Multiple Amouyal-Benoist. 11 references. (auth)

47324 ON THE ROOTS AND COEFFICIENTS FOR THE ENERAL SOLUTION OF THE REACTOR-KINETICS EQUATIONS. Kurstedt, Harold A. Jr.; Miley, George H. (Univ. of Illinois, Urbana). Nucl. Sci. Eng., 38: 80-2(Oct. 1969).

Tables based on thermal fission of coefficients and roots for use in neutron kinetics equations developed by Ash and by Keepin and Cox are presented. 8 references. (auth)

47325 MULTIGROUP CALCULATION OF CRITICALITY AND BURN-UP OF HOMOGENEOUS FUEL LATTICES. I. Sidorenko, V. D. (Inst. of Atomic Energy, Moscow). Kernenergie, 12: 159-62(May 1969). (In Russian).

The principles on which the programme MGR for calculating the criticality and the burn-up of homogeneous lattices is based are examined. Lattices with light water moderator are mainly considered. (auth)

47326 MULTIGROUP CALCULATION OF CRITICALITY AND BURN-UP OF HOMOGENEOUS FUEL LATTICES. II. Sidorenko, V. D. (Inst. of Atomic Energy, Moscow). Kernenergie, 12: 203-9(June 1969). (In Russian).

The multigroup calculations of burn-up were carried out with 4-group approximations which coincided with the boundaries suggested by Ombrellaro. The variations in the fuel isotopic composition were described by two chains starting with ^{232}Th and ^{238}U; the first chain ending with ^{237}Np and second with ^{244}Cm. Moreover, in the second chain the formation of ^{237}Np during the (n,2n) reaction on ^{238}U was taken into account. The accumulation of fission products was counted considering that each isotope during fission undergoes two neutron captures. Studies were made of 65 chains and 95 various isotopes. Continuous calculations were also made of the resonance integrals for U and Pu isotopes. In addition it was possible to recalculate the flow and mean cross sections in the thermal zone and, also, the spectrum according to the multigroup system. Finally, calculations were made of the ratio of small group flow along the cell zones. Critical parameter in the small group analog was determined by various methods. 20 references. (R.V.J.)

47327 DETERMINATION OF THERMAL-NEUTRON SPECTRAL INDEXES IN REACTOR CELLS NEAR PLANE ABSORBERS. Wennemo-Hanssen, S. E. (Institutt for Atomenergi, Kjeller, Norway). Nucl. Sci. Eng., 38: 42-7(Oct. 1969).

Thermal-neutron spectrum effects of plane boron-steel absorbers, covering a wide range of optical thicknesses, have been studied in the UO_2/H_2O zero power assembly NORA. An integral spectrum property has been determined in terms of a spectrum index defined by the activation ratio of the isotopes ^{176}Lu and ^{164}Dy. The experimental results demonstrated that the thermal spectrum is considerably hardened near the various absorbers. The hardening effects were found to extend 1 to 2 lattice pitches away from the absorbers. The experimental results have been interpreted by the Monte Carlo code MONTROSA which makes use of the Brown-St. John energy transfer model. When the computed values were adjusted to correspond with the Koppel-Young scattering model, and the experimental values were corrected for the influence of foil perturbations in moderator and epithermal activations, satisfactory agreement between computed and experimental spectral indexes was obtained in nearly all cases. 12 references. (auth)

47328 STOCHASTIC PROPERTIES OF NUCLEAR REACTORS IN A TWO-GROUP MODEL. Vaurio, J. K.; Jauho, P. (Technical Univ., Helsinki). J. Nucl. Energy, 23: 419-33(Aug. 1969).

The random processes of a zero-power reactor are studied using a point reactor model with two neutron groups. The probability balance equation with a general source term is written in terms of generating functions. Its solution is presented in terms of functions satisfying the sourceless Kolmogoroff equations. Recurrence formulas are stated for these functions and the criticality, the stationary, and the extinction probabilities of an autonomous reactor are studied. Differential equations for the mean values, variances, and covariances of the neutron populations are derived, and stationary solutions found for these. Autocorrelation and cross-correlation functions and power spectra are derived. The model suggests new experimental measurements, some of which are briefly described. (auth) (UK)

47329 FAST FISSIONS IN NUCLEAR REACTOR NOISE. Vaurio, J. K. (Helsinki Univ., Otaniemi, Finland). J. Nucl. Energy, 23: 435-8(Aug. 1969).

A probability generating function is derived for the number of neutrons and precursors born in a thermal fission and in the following fast fission generations. Expected values are derived and used to form quantities which appear in noise analysis and which are shown to be sensitive to the fast fission probability. Measurement of these quantities may therefore serve as a method of measuring the fast fission factor of nuclear reactors. The effective delayed neutron fraction may also be expressed in terms of the fast fission factor and the expected values. (UK)

47330 ESTIMATING THE MAXIMUM, DYNAMIC DEVIATION OF THE TEMPERATURE OF A HEAT TRANSFER AGENT IN A REACTOR. Dorri, M. Kh.; Solov'ev, M. M. At. Energ. (USSR), 27: 146-7(Aug. 1969). (In Russian).

A differential equation for the rate of change of the average temperature of the medium with time is written to describe the process of heat transfer in a reactor with variable flow of the heat transfer medium and average temperatures of the fuel elements and heat transfer medium. This equation is further simplified for limited rates of change of the variables. The results of calculating the temperature differences obtained from these two equations are to be compared. The equation is solved by using the idea of estimating the maximum temperature deviations which accumulate in the worst case. A simplified expression is obtained for the maximum dynamic temperature difference of the heat transfer agent at the reactor exit. The results are also presented in graphical form. Precise values of the temperature difference, calculated on a computer, did not exceed the maximum value obtained from the simplified expression. An example is presented. (TTT)

47331 CALCULATION OF ANGULAR DISTRIBUTION OF NEUTRONS IN NUCLEAR REACTORS. Nikolaishvili, Sh. S.; Lyashenko, E. I. pp 54-68 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

The angular distribution of neutrons in a one-dimensional system with a spherical or cylindrical symmetry was calculated using the differential part of the transport equation with the right part calculated by the method of spherical harmonics in $P_{\bar{3}}$ or $P_{\bar{5}}$ approximation. The problem of isotropic and linear-anisotropic laws of scattering was resolved by the multigroup method. (R.V.J.)

Experimental Applications

Refer also to abstract 47249.

47332 (CNM-R-2(Vol.3), pp 1446-59) GENERATION OF MULTIGROUP CROSS SECTIONS USING A COUPLED MC²-THERMOS CODE. Sargis, D. A.; Toppel, B. J.; Rago, A. L. (Argonne National Lab., Ill.).

Some preliminary results obtained by coupling the space dependent thermalization algorithms of THERMOS and the space independent epithermal MC² program are presented. The general theory is described wherein the slowing down sources from an MC² computation serve as epithermal sources for the thermal calculations in THERMOS. A discussion of results is given for three different systems: EBWR lattices; Hi-C lattices; and steam-cooled fast reactors. 6 references. (auth)

47333 (CNM-R-2(Vol.3), pp 1473-81) TRIX-2: AN ADVANCED ANALYTIC CALCULATION OF RESONANCE INTEGRALS AND DOPPLER COEFFICIENTS. Otter, J. M. (Atomics International, Canoga Park, Calif.).

Using basic resonance parameters, geometry, and concentrations, TRIX-2 computes resolved resonance, unresolved resonance, 1/v, and negative energy resonance contributions to effective resonance integrals. The first two contributions are Doppler-broadened using tabulated functions. Multigroup resonance integrals, cross sections, and temperature coefficients are formed. Provision is made for normalization to dilute cross sections, weighting by non-1/E fluxes, and for output on punched cards. 12 references. (auth)

47334 (CTC–5) KENO: A MULTIGROUP MONTE CARLO CRITICALITY PROGRAM. Whitesides, G. E.; Cross, N. F. (Union Carbide Corp., Oak Ridge, Tenn. Computing Technology Center). Sept. 10, 1969. Contract W-7405-eng-26. 123p. Dep. CFSTI.

KENO is a multigroup Monte Carlo criticality program written in Fortran IV, level H, for the IBM 360-65 and 360-75 computers. It contains a special geometry package which allows easy description of systems composed of cylinders, spheres, and cuboids (rectangular parallelepipeds) arranged in any order with only one restriction. This restriction is that each geometrical region must be described as completely enclosing all regions interior to it. For systems not describable using this special geometry package, the program can use the generalized geometry package (GEOM) developed for the O5R Monte Carlo code. It allows any system that can be described by a collection of planes and/or quadric surfaces, arbitrarily oriented and intersecting in arbitrary fashion. Rectangular arrays of fissile units are allowed with or without external reflector regions. The scattering treatment used in KENO assumes that the differential neutron scattering cross section can be represented by a P_1 Legendre polynomial. Absorption of neutrons in KENO is not allowed. Instead, at each collision point of a neutron tracking history the weight of the neutron is reduced by the absorption probability. When the neutron weight has been reduced below a specified point for the region in which the collision occurs, Russian roulette is played to determine if the neutron's history is to be terminated at that point or if the neutron is to survive with an increased weight. Splitting of high weight neutrons is allowed in order to minimize the variance in k_{eff} for systems with regions of widely varying average weights. 5 references. (auth)

47335 MEASURING THE PERIOD OF A REACTOR. Armenskii, E. V.; Zakharov, B. A.; Potekhin, A. M. Izmer. Tekh., No. 6, 54-5(June 1969). (In Russian).

Three methods of measuring the reactor period are briefly discussed. It is possible to determine the log of the power and then differentiate with respect to time, or it is possible to determine the time derivative of the power and divide by the instantaneous power. By measuring the period with a log amplifier it is possible to carry out a continuous measurement of the period over a wide range of reactor powers. Hence this method has found favor in automatic startup of a reactor where the power varies over 6 to 8 orders of magnitude. The greatest accuracy is required for measuring periods of 20 to 40 sec. A block scheme of measuring the period is presented in which a divider is used. The incoming signal enters a linear current amplifier. The voltage from the exit of this unit is fed to a differentiating amplifier, from which the exit voltage goes to a divider. The exit voltage from the divider determines the reactor period. Experimental confirmation of this method indicates that it is relatively simple to use. (TTT)

47336 VIBRATION CORRELATION FOR MAXIMUM FUEL-ELEMENT DISPLACEMENT IN PARALLEL TURBULENT FLOW. Reavis, J. R. (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 38: 63-9(Oct. 1969).

Fuel elements have been observed to vibrate in turbulent parallel flow. Available data describing the fluctuating pressure in a turbulent boundary layer are used to calculate fuel-element response to boundary-layer turbulence. The disparity between calculated and experimental response is attributed to an incomplete description of pressure fluctuations in the test facilities. A coefficient is obtained which correlates available fuel-element vibration data with the theory. 13 references. (auth)

47337 LINEAR EXTRAPOLATION DISTANCES FOR CENTRAL AND ECCENTRIC CONTROL RODS IN CYLINDRICAL GEOMETRY: AND EXPERIMENTAL STUDY. Borak, Fahir Ibrahim. New York, New York Univ., 1968. 144p.

Thesis.

Linear extrapolation distances for central and eccentric black control rods in cylindrical geometries have been determined by the pulsed neutron method. It is found that for a given radius control rod, extrapolation distance increases with increasing moderator radius. Linear extrapolation distance is also found to increase with eccentrical location of control rods. In general, the values of the extrapolation distances determined for central rods, in the range of moderator radii studied, are higher in value by 10 to 100% than those given by the theoretical calculations of Davison and Kushneriuk. The values of the linear extrapolation distances for eccentric control rods, in the range of moderator radii studied, are also higher than the central control rod extrapolation distances up to a factor of 6, the increase depending on the location of the control rod. Diffusion parameters of water moderator assemblies, to study the dependence of these coefficients on the radial-to-axial buckling ratio, have also been determined by the pulsed neutron method. No dependence of the diffusion parameters on radial-to-axial buckling ratio has been observed. (Disser. Abstr.)

Reactor Components, Fuels, and Accessories

Refer also to abstracts 45217, 45442, 45465, 45467, 45469, 45486, 45497, 45576, 45578, 45600, 45987–45991, 46009, 46010, 46019, 46039, 46088, 46090, 46091, 46106, 46112, 46113, 46121, 46130, 46133, 46146–46148, 46152, and 47249.

47338 (AECL–3111) IRRADIATION BEHAVIOUR OF SOLID AND HOLLOW U_3Si FUEL ELEMENTS: RESULTS TO 15,000 MWd/tonne U. Feraday, M. A.; Chalder, G. H.; Cotnam, K. D. (Atomic Energy of Canada Ltd., Chalk River (Ontario). Chalk River Nuclear Labs.). June 1969. 37p. (EXP-NRX–52233). Dep. CFSTI (U. S. Sales Only). CAN $1.00.

U_3Si fuel elements clad in Zr alloy sheaths have been irradiated to burnups close to 15,000 MWd/tonne U in pressurized water at 220°C, 98 bars. The results show that the external swelling can be controlled by incorporating free volume in the element. The dimensional stability of such elements is adequate to permit their use in power reactor fuel bundles. A diameter increase of 1.2% had occurred in an element initially containing 12.8% total free volume, after a burnup of 14,700 MWd/tonne U. There was no change in diameter between burnups of 5200 and 14,700 MWd/tonne U. Elements containing 3% total free volume had increased in diameter about 2.5% at 2000 MWd/tonne U compared to 0.2% at 9500 MWd/tonne U for elements containing 22% total free volume. The observed swelling in the U_3Si is discussed in terms of possible mechanisms. (16 references) (auth)

47339 (BNWL–1106) PLUTONIUM UTILIZATION PROGRAM. Technical Activities Quarterly Report, March–May 1969. (Battelle-Northwest, Richland, Wash. Pacific Northwest Lab.). July 1969. Contract AT(45-1)-1830. 70p. Dep. CFSTI.

CRITICAL ASSEMBLIES—power distributions in water moderated and reflected, two region reflector model analysis of, (E/T)
—reactivity temperature coefficient of water moderated mixed oxide fueled, endogenous pulsed source method measurements of
GAMMA RADIATION—spectra from lithium-activated germanium detectors, analysis of peak shapes in
NEUTRONS—resonance absorption by absorber or moderator nuclei, revisions to HRG code for analysis of
PLUTONIUM—plutonium-236 and plutonium-238 content in recycled, effect of recycled enriched uranium on
PLUTONIUM OXIDES PuO_2—PuO_2–UO_2, fission gas release from irradiated vibrationally compacted fuels of
PLUTONIUM RECYCLE CRITICAL FACILITY—critical experiments in Batch Core fueled, spectrum and leakage correction to effective multiplication factors in
—critical experiments in water moderated and reflected lattices in, ratio of effective delayed neutron fraction to mean neutron lifetime for, (E/T)
PLUTONIUM RECYCLE TEST REACTOR—fuel element testing in, status of high power density plutonium oxide (PuO_2)–uranium oxide (UO_2)
RADIATION DETECTORS, SEMICONDUCTORS (GERMANIUM)—gamma spectra from lithium-activated, analysis of peak shapes in
REACTORS, BOILING—coolant void fraction fluctuations in, effects on reactivity and isotopic composition of fuel elements from, (T)
REACTORS, POWER—physics analysis of, revisions to FLARE code for
URANIUM—effect of recycled enriched, on plutonium-236 and plutonium-238 content of recycled plutonium fuel
URANIUM OXIDES UO_2—PuO_2–UO_2, fission gas release from irradiated vibrationally compacted fuels of
—radiation testing of Zircaloy clad vibrationally compacted fuels of, effects of transient
ZIRCALOY-2—metallography of transient irradiated fuel cladding of (H.D.R.)

47340 (CNM-R-2(Vol.3), pp 1428-45) ARGONNE REACTOR COMPUTATION SYSTEM, ARC. Kelber, C. N.; Jensen, G.; Just, L.; Toppel, B. J. (Argonne National Lab., Ill.).

A description of the Argonne Reactor Computation System is presented. The system uses an IBM-360/50-75 computer com-

plex. The data organization, system structure, and applications are described. 5 references. (D.C.C.)

47341 (GEAP-5748) HEAT TRANSFER COEFFICIENTS BETWEEN FUEL AND CLADDING IN OXIDE FUEL RODS. Craig, C. N.; Hull, G. R.; Baily, W. E. (General Electric Co., Sunnyvale, Calif. Breeder Reactor Development Operation). Jan. 1969. Contract AT(04-3)-189. 42p. Dep. CFSTI.

Coefficients of heat transfer between fuel and cladding were determined from in-pile irradiations. Values of 1150, 750, and 520 Btu/h-ft^2-°F were obtained for initial nominal fuel-cladding gaps of 0.002, 0.004, and 0.010 inch in the power range from 17.5 to 20.0 kW/ft. Heat transfer coefficients obtained for mixed oxide fuel rods irradiated in a fast flux for burnups ranging from 1500 to 50,000 MWd/Te are also presented. 22 references. (auth)

47342 (WARD-3791-37) OXIDE FUEL ELEMENT DEVELOPMENT. Quarterly Progress Report for the Period Ending March 31, 1969. (Westinghouse Electric Corp., Madison, Pa. Advanced Reactors Div.). May 1969. Contract AT(30-1)-3791. 61p. Dep. CFSTI.

The rupture limits for Type 316 stainless steel are measured, and the effects of annealing and cold working are illustrated. Welding techniques are described for fabricating hexagonal spacer grids of Type 316 stainless steel. Fabrication of PuO_2-UO_2 fuel pellets is discussed. Clad swelling equations for Type 304 stainless steel in fast neutron flux are tested for accuracy. (22 references) (D.C.C.)

47343 (ZJE-49) REACTOR CALORIMETER CALIBRATION THEORY. Kott, J. (Skoda Concern, Pilsen (Czechoslovakia). Nuclear Power Plants Div.). [nd]. 36p. Dep. CFSTI (U. S. Sales Only).

The complete reactor calorimeter calibration theory is discussed. Methods of thermal energy accumulation as a result of reactor radiation effects in matter, analysis of reactor calorimeter thermal leakage, relations valid for calculation of the total amount of absorbed radiation energy in the calorimeter sample, and operation regimes of radial-flow reactor calorimeters are included. Differences in temperature distribution of calibration and radiation heatings inside calorimeter samples are analyzed. In the analysis special attention is paid to the adiabatic and isothermic regimes of calorimeters. Also discussed are relations for the calibration analysis of the cooling curves after the radiation heating inside the reactor. As a conclusion, time criteria are summarized determining the equivalence between the calibration and radiation heatings of the radial-flow reactor calorimeter and also given is the survey of materials for which the comparative calculations were effectuated. (auth)

47344 NUCLEAR TRAINING CENTER USES DIGITAL SIMULATION. Elec. World., 170: No. 4, 24-5(July 22, 1968).

A digital computer real-time simulator is described for training operators of 800 MW(e) boiling reactors. The proposed operator training schedule and simulator operation procedures are presented. (D.C.C.)

47345 MANIPULATOR FOR NUCLEAR FUEL. (to Compagnie Generale d'Automatisme). British Patent 1,163,641. Sept. 10, 1969. Priority date June 6, 1966, France.

REACTOR LOADING MACHINES—design parameters for pneumatic actuated flexible tube gripper type

REMOTE-HANDLING EQUIPMENT—design parameters for pneumatic actuated flexible tube gripper type (D.C.C.)

47346 HYDRO-ELASTIC BEHAVIOR OF MULTIPLE-PLATE FUEL-ASSEMBLIES. II. HYDRO-STATIC DIVERGENCE. Wick, R. S. (Texas A and M Univ., College Station). J. Nucl. Energy, 23: 407-18(Aug. 1969).

An analysis of hydraulically induced fuel-plate collapse is presented which takes into account the coupling through the elastic structure of pressure disturbances in all the flow channels of a fuel assembly. No a priori assumption is made regarding the mode of plate deflection. This more general formulation is shown to be equivalent to that of other investigators only if special assumptions about the construction of the fuel assembly are made. (auth) (UK)

47347 HYDRO-ELASTIC BEHAVIOR OF MULTIPLE-PLATE FUEL-ASSEMBLIES. I. PRESSURE WAVE PROPAGATION. Wick, R. S. (Texas A and M Univ., College Station). J. Nucl. Energy, 23: 387-405(Aug. 1969).

A simplified analysis of a finite number of fuel plates is presented in which are considered some of the aspects of the coupling of hydraulic phenomena with the elastic structure of the fuel assembly. The phenomena of pressure wave propagation in internally complex-conduits similar to reactor fuel elements are discussed. The theory takes into consideration the coupling of pressure disturbances in adjacent channels through elastic-flexible walls separating the flow passages and neglects the inertia of the plates. It is shown that many modes of pressure (and rarefaction) wave propagation are possible, and that, for fuel assemblies of interest to reactor designers, the velocity of pressure wave propagation may be considerably less than the velocity of sound in the coolant. These results indicate the importance of considering the fuel assembly as a whole when analyzing (a) rapid reactor transients, (b) the spatial formation of voids due to rarefaction waves, and (c) extending present models of vibration and fuel plate collapse. (auth) (UK)

47348 NUCLEAR REACTORS. Jones, Cecil Henry (to United Kingdom Atomic Energy Authority). British Patent 1,161,886. Aug. 20, 1969. Filed Mar. 7, 1966.

Reference is made to reactors employing fuel element assemblies comprising clusters of parallel spaced fuel elements, supported by cellular grid structures; such assemblies can be subject to vibration, due to the coolant, which can cause them to make contact with and damage the walls of the fuel element channels. In the system described at least one of the grid structures has an outwardly extending circumferential rib, axially displaced from the cells of the grid structure in the downstream direction of coolant flow, with an annular clearance between the rib and channel wall, this clearance being 1 to 2% of the channel bore diameter, and having a width of 1.36 to 1.88% of the bore diameter. (UK)

47349 IRRADIATION CAPSULE OF THE REACTOR-CORE ELEMENT TYPE. Tanaka, Isao (to Japan Atomic Energy Research Inst.). Japanese Patent 1969-12639. June 6, 1969. Filed Feb. 9, 1966.

The irradiation capsule proposed, which is shaped like a fuel element, has the following advantages: measuring lead-wires sealed in the capsule itself; irradiation of many specimens at the same time; and smooth insertion of a capsule into the reactor core. The capsule is a long square rod with supports at top and bottom. In the middle, a cavity is formed along length of the capsule. A plate covers the cavity. Test specimens are stacked in the cavity with suitable spacers. When it is necessary to attach measuring lead wires to them the wires are connected to the specimens, and both the specimen and the wires are sealed. The lead wires run through the upper solid part of the fuel-element shaped capsule, again properly sealed at the exit. Coolant channels are provided through the capsule. (NSA of Japan)

47350 IRRADIATION-EXPERIMENT HOLE DEVICE IN A REACTOR. Takahashi, Jiro (to Meidensha Electric Mfg. Co.). Japanese Patent 1969-12638. June 6, 1969. Filed Nov. 26, 1964.

A sample material in a capsule is sent into the reactor and taken out by means of a liquid through a double-walled tube. In introducing a capsule, liquid flows through the inner tube and comes out through the space between the two walls; in withdrawing it, the direction of liquid flow is reversed. (NSA of Japan)

47351 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Ackroyd, Ronald Tunstall; Perks, Maurice Arthur (to United Kingdom Atomic Energy Authority). British Patent 1,161,599. Aug. 13, 1969. Filed Dec. 23, 1965.

Reference is made to nuclear reactors of the type having a core surrounded by a segmented reflector. Variation of reflector geometry enables neutron leakage from the core to be varied, hence obtaining a measure of reactivity control. Hitherto this system has been confined to solid reflectors, requiring machinery for moving the segments. The system described employs liquid reflectors and obviates the requirement for machinery. The reflector segments extend in juxtaposed relationship at least from the top to the bottom ends of the core, and each segment comprises a container for the liquid reflector; means are provided enabling the liquid content in any pair of mutually adjacent containers to be varied independently. A variable pressure gas supply is provided to operate the liquid levels. The reflector liquid may carry fertile material incorporated in a buoyant body. The reflector liquid may be a lead alloy. (UK)

47352 BIOLOGICAL SHIELDINGS FOR NUCLEAR REACTOR ARE CALCULATED AS FUNCTIONS OF TEMPERATURE LOAD. Pergamenshchik, B. K.; Khol'tsov, A. V.; Shershnev, S. T. pp 234-45 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Thermal intensity in nuclear reactor shielding construction was

estimated and it is shown that considerable temperature fluctuations do not interfere with the rise of ferroconcrete shieldings. The deformation and stress on the shielding at 200 to 300°C and cracks of 0.1 to 0.3 mm in the zone of 20 to 30% greater thickness are safe with ordinary concrete shieldings. (R.V.J.)

47353 SELECTION OF OPTIMUM METAL–WATER REACTOR SHIELDINGS. Suvorov, A. P.; Fedorenko, R. P. pp 6-23 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Optimization variations for one-dimensional plane and spherical heterogeneous shieldings with a fixed concentration of materials (lead, boron, iron, and water) inside of each layer are discussed. (R.V.J.)

47354 SHIELDING PROPERTIES OF ELEMENTARY UNITS OF HETEROGENEOUS METAL–WATER NUCLEAR REACTOR SHIELDINGS. Broder, D. L.; Kondrashov, A. P. pp 161-71 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.). Moscow, Atomizdat, 1969. (In Russian).

Biological shielding properties of elementary cells of heterogeneous metal-water shieldings (water, lead, and steel) were studied considering secondary emissions and their interrelations. (R.V.J.)

47355 PROBLEMS RELATED TO THE REDUCED YIELD OF CAPTURED γ-RADIATION. Artem'eva, N. A.; Broder, D. L.; Kozlovskii, S. A.; Kondrashov, A. P.; Popkov, K. K.; Tabolina, L. N. pp 173-8 of Voprosy Fiziki Zashchity Reaktorov. Broder, D. L.; Suvorov, A. P.; Tsypin, S. G. (eds.).

The reduced yield of capture γ-radiation from the steel structures and coefficients of secondary radiation blocked by boron containing materials or by lead were calculated as functions of steel structure thickness and the thickness of subsequent shielding. (R.V.J.)

47356 NONDESTRUCTIVE BURN UP DETERMINATION BY γ-SPECTROSCOPY. PART II. CALCULATION OF BURN UP FROM THE γ-SPECTRA OF FISSION PRODUCTS. Knoth, J.; Sandrock, F.; Schwenke, H.; Wille, P. (Institut fuer Reaktorphysik, Geesthacht/Elbe, Ger.). Atomkernenergie, 14: 342-6(Sept.–Oct., 1969). (In German).

A computer program system is given which determines the burnup of fuel rods by fission product-γ-spectra. Special attention has been paid to the determination of corrections which are necessary due to the non-linear buildup of the fission product activities, particularly with shortlived nuclides. The error of these corrections results from inexact knowledge of the reactor operation data. It has been calculated and used for the evaluation. (auth)

GENERAL

47357 (ANL/ES-RPY-1) MATHEMATICAL URBAN AIR POLLUTION MODELS. Moses, Harry (Argonne National Lab., Ill.). Apr. 1969. Contract W-31-109-eng-38. 69p. Dep. CFSTI.

The use of mathematical models for urban air pollution problems is reviewed, and five tables are presented including the locations of the studies, types of tracers, sizes of the monitoring and meteorological networks, amounts of data collected, and the mathematical equations used. The urban air pollution model is considered as having four components including the source inventory, the network of meteorological stations, the network of pollutant monitoring stations, and the mathematical algorithm which describes the processes that transform the concentrations at the sources to those observed at the receptor. Two general categories of mathematical models are discussed. These are the source-oriented and receptor-oriented models of which there are three types. Verification techniques summarized include scatter diagrams, correlation coefficients, and isopleth comparisons. The weaknesses and strengths of validation techniques are discussed. (J.C.W.)

47358 (LA-4122-TR) TEMPERATURE DEPENDENCE OF GASEOUS NORMAL AND ORTHO-DEUTERIUM THERMAL CONDUCTIVITIES AT LIQUID HYDROGEN TEMPERATURES. Uebelhack, W.; Eichenauer, W.; Heinzinger, K.; Klemm, A. Translated by A. D. Cernicek (Los Alamos Scientific Lab., N. Mex.), from Z. Naturforsch., 22a: 1528(1967). 5p. Dep. CFSTI.

The relative thermal-conductivity differences of gaseous normal and ortho-deuterium have been measured at three different temperatures, 18.5, 19.8, and 21.1°K. The results are 0.97×10^{-3}, 1.08×10^{-3}, and 1.45×10^{-3}, respectively, with an accuracy of ±10%. They are compared with the relative viscosity differences for the two deuterium modifications. This comparison leads to a difference in f_{tr} and f_{int} for normal and ortho-deuterium in the Eucken relation. (auth)

47359 (LA-4228) APPLICATION OF THE NELDER-MEAD SIMPLEX METHOD TO FINDING THE ZEROS OF POLYNOMIALS. Motteler, Zane C. (Los Alamos Scientific Lab., N. Mex.). July 31, 1969. Contract W-7405-eng-36. 43p. Dep. CFSTI.

The use of the Nelder–Mead simplex scheme (for minimizing functions of several variables) in determining the zeros of a polynomial by means of a systematic search of the complex plane is described. The results obtained from a code using this method are compared with those obtained from a previous code developed by the author, using a method of descent. (auth)

47360 (LA-tr-69-18) A STUDY OF VOLTERRA INTEGRAL EQUATIONS WITH REFERENCE TO THEIR NUMERICAL TREATMENT. Pouzet, P. Translated for Los Alamos Scientific Lab., N. Mex., from Rev. Fr. Trait. Inform., 6: 79-112(1963). 51p. Dep. CFSTI.

The principal ideas of a theory connecting the study of Volterra integral equations (of a very general explicit form) with the standard study which has been elaborated for the numerical treatment of initial value differential problems are summarized. The single-step formulas of Runge Kutta and the multi-step formulas used in these latter problems are generalized with a view toward the approximation of the solution of these equations. The mathematical techniques set forth allow the successful undertaking of a similar study for Volterra integrodifferential equations and for a class of bi-integral equations of the same type. (auth)

47361 (ORNL-4407) COMPUTER METHODS OF CALCULATING SULFURIC ACID ACTIVITY, SULFATE ION CONCENTRATION, AND IONIC STRENGTH OF SODIUM SULFATE–SULFURIC ACID SOLUTIONS. McDowell, W. J. (Oak Ridge National Lab., Tenn.). Aug. 1969. Contract W-7405-eng-26. 19p. Dep. CFSTI.

Four programs for calculating formal and ionic concentrations in mixed sodium sulfate–sulfuric acid solutions are described. Two of the programs calculate the sulfuric acid concentration required in a given total sulfate ($H_2SO_4 + Na_2SO_4$) concentration to produce a specified sulfuric acid activity and also calculate ionic composition and ionic strength of the resulting solution. The other two programs calculate the ionic composition and strength and sulfuric acid activity of solutions of specified formal composition. The methods of operation of the programs are described, their theoretical basis is outlined, and listings are presented. (auth)

47362 (SC-DR-69-329) FRAGMENT VELOCITY MEASUREMENTS FROM THREE PROJECT PYRO EXPERIMENTS. Jeffers, S. L. (Sandia Labs., Albuquerque, N. Mex.). June 1969. 18p. Dep. CFSTI.

Several motion picture films of Project PYRO liquid propellant explosive experiments were reviewed to determine a fragment velocity profile. Of the films available to Sandia, only the films from three events were usable for this determination. All three events were in the 25,000-pound series. One was a LO_2/RP-1 in-tank experiment, and two were LO_2/LH_2 drop tests. The fragments examined were limited to those traveling in an upward direction where they might damage a spacecraft mounted on a launch vehicle; because of the viewing distance, it was impossible to determine the origin or constitution of the fragments. It was also impossible to measure the velocities close-in to the detonation because the vicinity was obscured by the combustion products of the fireball. Only after the fragments had exited the fireball could their velocities be measured. The fragment trajectories were extrapolated backward into the fireball, and their velocities were determined 10 feet from the initial position of the upper dome. These velocities ranged from 190 to 3040 fps. Velocity distributions of the several fragments observed are plotted. (auth)

47363 (SC-M-69-401A(Pt.1)) PROGRAM WINNOW: USER'S MANUAL. Faw, Lewis A. (Sandia Labs., Albuquerque, N. Mex.). Sept. 1969. 55p. Dep. CFSTI.

Program WINNOW for editing, checking, and correcting data which represents a printed circuit board is described. It edits input, checks all circuitry for specified clearances and makes corrections where necessary for good connections of circuitry elements. The input to WINNOW is digitized data prepared for the Gerber NC drafting machine. The output from WINNOW consists of: (1) corrected data for the Gerber (magnetic tape or cards), (2) a drawing which relates x and y coordinate data to drill holes and terminals (lands), and (3) an S-C 4020 plot of the board overlaid with a coordinate grid for checking purposes. Program WINNOW is written for the CDC-3600 computer and for the UNIVAC 1108 computer. The 1108 program has two versions: a standard version which will handle the data for a board containing about 800 terminals, and a segmented version for about 1400 terminals. (auth)

47364 (SCL-RR-69-67) ASSESSMENT OF THE PROPER BOUNDARY CONDITIONS AT THE OUTER EDGE OF THE TURBULENT BOUNDARY LAYER ON SPHERICALLY BLUNTED CONICAL BODIES. Witze, P. O.; Hartley, D. L. (Sandia Labs., Livermore, Calif.). Sept. 1969. Contract AT(29-1)-789. 38p. Dep. CFSTI.

An integral mass-balance technique is presented for determining the thermodynamic properties at the edge of a turbulent boundary layer in the region where the curved bow shock influences the flow. The importance of compressibility, the use of integral versus local methods, and the location of the virtual origin of the turbulent boundary layer are also discussed. (auth)

47365 (TID-5001(9th Rev.)) SUBJECT HEADINGS USED BY THE USAEC DIVISION OF TECHNICAL INFORMATION. Lanier, Sidney F. (ed.) (Division of Technical Information Extension (AEC), Oak Ridge, Tenn.). Sept. 1969. 276p. Dep. CFSTI.

The subject heading authority, an information indexing and retrieval tool used by the Division of Technical Information Extension (DTIE) in preparing subject indexes to the literature abstracted in Nuclear Science Abstracts (NSA) and in searching these indexes either by manual or machine-assisted means, is presented. The subject heading terms are supplemented with cross references that aid in subject heading selection for indexing and retrieval and enable the user to modify, enlarge, or narrow his coverage in accordance with his particular needs. Appendixes are included that provide a list of the elements and their symbols and a list of acceptable modifier file words for Nuclear Science Abstracts. (auth)

47366 (UCRL-50663) TRUMP/XB2: A COMPUTER PROGRAM FOR PROCESSING THE TRUMP THERMAL PROPERTY DATA COMPILATION. Edwards, Arthur L. (California Univ., Livermore. Lawrence Radiation Lab.). May 9, 1969. 50p. Dep. CFSTI.

The TRUMP/XB2 computer program was developed for processing the TRUMP Thermal Property Data Compilation. The data include densities, transition temperatures, heats of transition, and

tables of specific heat and thermal conductivity vs temperature, for over 1000 materials. An alphabetical material index, list of data sources, material-classification system, data-quality indicator system, and the data themselves are on computer cards and magnetic tapes. The data are in the format used for material property input data in the TRUMP program. Processing options available with the TRUMP/XB2 program include (a) reading the material data, checking for various types of format errors, calculating tables slopes, calculating enthalpies from specific-heat tables, and writing out the input data, error diagnostics, and calculated data; (b) conversion of the material data to any desired unit system; (c) producing a secondary material data list from the master data list, including all the materials or only the materials on a material selection list; (d) producing graphs of specific heat and thermal conductivity vs temperature; and (e) any combination of these. Planned future development includes addition of procedures for updating the material data list and alphabetical index, searching for materials with properties in specified ranges, and other searching and sorting procedures. (auth)